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Empirical Analysis of Job Security and Wage Stability at Public Institutions

December 2014 | Jongsuk Han

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Introduction

The Korean government has recently unveiled the Public Institution Normalization Policy, thus tightening its control over the already excessive debt and fringe benefit expenses of public institutions, which are frequently criticized for their lax management. However, before tackling lax management at public institutions with policy measures, we need to first determine the appropriateness of the wage and remuneration system used by these institutions.

The main reason the wage level in the public sector should be analyzed and reviewed continually can be found in the fact that the public sector is not and should not be run according to market principles only. In the private sector, the equilibrium wage and equilibrium number of jobs are determined in the exchange of labor that occurs on the basis of the labor supply function deriving from the utility-maximizing behavior of employees and the labor demand function deriving from the profit-maximizing behavior of employers. Employees and employers who seek wages or numbers of employees outside these equilibrium levels are naturally forced out of the labor market, which will move toward new equilibria in response to external shocks. In such a market economy, there is no need to question whether a given equilibrium wage level is "appropriate." However, this is not the case for the public sector. The public goods and services that the public sector provides fundamentally differ from the goods and services provided by the private sector. Public goods and services would never arise in the first place if left alone to the whims of the market, and are also required to satisfy public interests. Therefore, the public sector, which is responsible for producing and distributing these public goods and

services, cannot determine its demand for labor through profit-maximizing behavior only. This inability, in turn, makes it difficult for us to estimate labor productivity—necessary for determining the wage level elsewhere—in the public sector. The employer in the public sector is our government, which derives its revenue from taxation and spends part of that revenue on wages and rewards for its employees. Accordingly, the wage level in the public sector has been decided traditionally as a matter of policy rather than a matter of labor productivity. For this reason, the wage level in the public sector has been a topic of much debate and research. The established literature on this issue focuses mainly on debating whether the wage level for government employees is appropriate, and, if not, how it can be made more appropriate. However, as the number and diversity of government-invested institutions multiply, hiring significantly greater numbers of people, more and more researchers today strive to provide a comparative analysis of wage levels in the public and private sectors.

There are also studies that strive to demonstrate empirically whether there is really a wage gap between the two sectors. An increasing number of studies published in recent years make use of diverse types of micro-data to analyze and determine the causes behind the relatively higher wage level in the public sector, particularly at public institutions. The consensus so far is that the wage level at these institutions is higher not because the government has decided to pay higher wages, but because these institutions hire relatively greater proportions of well-educated, highly-skilled people. Nevertheless, we have yet to discover why such well-educated, highly-skilled people prefer to work for public institutions rather than in the private sector. This study takes an in-depth approach to this question, analyzing job security and wage stability at public institutions so as to determine how these two factors affect job candidates' choice of workplace.

In the following Section II, this study provides a survey of the existing literature on the wage gap between the public and private sectors, while Section III explains the Korean Labor and Income Panel Survey (KLIPS) data, which are frequently used in empirical studies, and discusses the sampling process and the variables that have been used in the empirical analysis. In Section IV, before proceeding to the analysis of job security and wage stability at public institutions, this study estimates and analyzes whether there is indeed such a wage gap,

and if so, attempts to determine how large it is and what factors have led to such a gap. Diverse wage equations are used to this end. Sections V and VI provide in-depth analyses of job security and wage stability at public institutions, while Section VII estimates and compares the potential wage levels of the public and private sectors based on the wage equations and probability of survival. The potential wage levels are then used for the quantitative analysis of the wage gap, reflecting the different levels of job security. Section VIII provides a brief summary of the findings made throughout the course of this study.

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Literature Survey

There is a growing body of research on the wage gap between the public and private sectors in Korea. The methodologies, types of data, definitions of the public sector, and targets of comparison used in these studies are indeed diverse.

Upon surveying the literature on the public sector, it can be found that the public sector is roughly divided into governmental and semi-governmental organizations, government-invested institutions, government-affiliated institutions, and state-owned enterprises or public corporations. Article 4.1 of the Act on the Management of Public Institutions defines a public institution as "an institution that is established and/or run with the investment, capital contributions, or fiscal support of the government" as well as an institution that the Minister of Strategy and Finance officially designates according to the terms of the Act. In the past, researchers mainly focused on the wage gap between government employees (i.e., those directly involved in civil service) and private business employees. The increasing number and diversity of public institutions coupled with the increasing number of people they hire today has prompted more and more researchers to specify and narrow the scope of their comparative analyses of the public sector. Major examples of the former type of research include Cho (1998) and Kim et al. (2000). Using the Korean Household Panel Survey data of the Daewoo Research Institute from 1993 and 1994, Cho (1998) conducts an empirical analysis of the earned income of government employees and private business employees. He defines the net wage gap as "the difference in the amount of wage a given government employee would receive in a private business in

comparison to the wages of other private business employees with similar academic and employment backgrounds." His analysis reveals that, on average, government employees receive 3.1 percent less than their private-sector counterparts in terms of monthly wages. Kim et al. (2000) conclude that the wage level of government employees is 11 percent lower than that of their private-sector counterparts. They derived their data on government employee wages from the raw data of the Comprehensive Government Employee Survey of 1998, the wage lists of 1997, and the data on private-sector wages from the Basic Statistics on the Wage Structure. Their study notes that the "private sector" needs to be defined and specified with clarity in order to support an effective comparative analysis.

Jeong and Eoh (2000) thus limit their comparison to government employees of Grades 7 and 9 and employees of private businesses employing at least 100 persons. To control other factors that affect wage levels, such as employees' academic backgrounds and areas of work, the authors derive a wage equation applicable to both the public and private sectors. Their analysis reveals that government employees receive lower salaries than their private-sector counterparts irrespective of their rank or seniority, while the size of the wage gap differs by rank. These three studies all involve running regression analyses to find wage equations applicable to both sectors. Moreover, they also divide the wage gaps they found between those attributable to the idiosyncrasies of employees, on the one hand, and the structural differences in the rates of return for human capital in the public and private sectors, on the other.

Lee (1996), Kim (1996), Heo et al. (2007), and Lim et al. (2000) all analyze the wage gap between public institutions and private businesses, but use different sets of data. Lee (1996) appears to use data that the author directly collected from a few public institutions and private businesses, but fails to identify the specific sources. Kim (1996), on the other hand, uses the Korean Household Survey Panel data from 1994 (gathered by the Daewoo Research Institute, which was the predecessor to today's KLIPS), while Heo et al. (2007) uses the KLIPS data from 2002. Kim and Heo et al. differ from other studies in that they use more advanced methods than the Mincer-type regression analysis. Unless the individuals in these samples chose the respective sectors in which they work at random, individual choice is also an important variable affecting

the wage level in each sector. In order to control this variable, which is known as the "sample selection bias," Kim and Heo et al. employ a two-stage estimation process that first estimates the selection random variables using multinomial logit models, and then use those variables in their wage equations. Known as the "sample selection model with multiple choices," this methodology was first developed by Heckman (1979) and included only two choices, but Lee (1983) later expanded the model to include more choices. The multinomial logit model estimations in these two studies reveal that the wage level at public institutions is higher than at private businesses.[1] Lim et al. (2009) uses business panel data from 2006 to perform a comparative analysis of the wage-deciding factors at public institutions and private businesses. Whereas other studies control the idiosyncrasies of individual employees and strive to empirically demonstrate the wage gap between the public and private sectors, Lim et al. attempts to explain the wage gap in terms of the particular characteristics of each sector. This study, however, uses business panel data as these data provide more information on the characteristics of employers (i.e., businesses) than the KLIPS data and others, which focus on households and employees. Although the wage level in the private sector may be determined according to market principles, the wage level in the public sector is influenced far more by other factors, such as the government budget and remuneration policy. Other studies, however, fail to take into account this important distinction. Lim et al. therefore focuses on this distinction in their analysis of the wage gap. As such, this study's empirical analysis controls individual idiosyncrasies by using the initial wage levels of male, college- and high school-educated, full-time employees as dependent variables, instead of including such idiosyncrasies as factors in the regression formula. Even after controlling the different wage-deciding systems and levels of exposure to market competition, Lim et al. reveals that the wage level at public institutions is higher

1) The selection variables included in Kim (1996) were government employees (civil service), government–invested (public) institutions, private corporations, and small–to–medium private businesses. Government–invested institutions boasted the highest wage level, followed by private corporations, civil service, and small–to–medium private businesses, in the descending order. Heo et al. (2007), on the other hand, used as selection variables the unemployed, public institutions, private corporations, and self–employed businesses. This study also concludes that the wage level at public institutions is higher than that in the private sector

than that in the private sector.

Rah et al. (2013) and Jeon (2014) may appear not so distinct from the earlier studies—Cho (1998), Kim et al. (2000), Heo et al. (2007), etc.—in terms of the methodology they use. These two studies, however, are significant in that they base their analyses of the wage gap on wage data they gathered directly from public institutions. The other studies base their findings on generally accessible information, such as the KLIPS data and the Labor Status Surveys by Employment Type, in spite of the fact that these pools of data represent the employees of relatively few public institutions. Recognizing this core shortcoming, the authors of the two latest studies have carried out actual surveys of wage levels by employee type at each public institution as well as the individual characteristics of the employees. Both studies conclude that, while the average wage level is higher at public institutions than in the private sector, much of the wage gap reflects the idiosyncrasies of public institution employees, such as their relatively stronger educational and employment backgrounds. In particular, Jeon (2014) shows that, of the average gap of KRW 1.24 million in the monthly wage between public institutions and private businesses, KRW 1.1 million (88 percent) is a direct result of the idiosyncrasies of employees, and only KRW 0.14 million (12 percent) is caused by the structural characteristics of public institutions. Even that 12-percent difference reflects the fact that employees of public institutions tend to work longer at the same workplace than their private-sector counterparts. With this seniority factor also controlled, the two studies conclude that public institutions offer no "wage premiums."[2)]

In other words, these studies reach different conclusions regarding the existence of public-sector wage premiums depending on the types of data and control variables they use. Studies that did not control such variables as occupation type, industry type, and business size conclude that public institutions do offer higher wages than private businesses. On the contrary, studies that did not control these variables reveal that either the public-sector wage premium

2) Rah et al. (2013) and Jeon (2014) control as much of the business-specific characteristics as possible, such as occupation type, industry type, and business size. Jeon (2014) shows that, when these variables are not controlled, the wage level at public institutions appears to be 24.6 percent higher than that at private businesses. When they are controlled, however, the wage premium disappears

does not exist or that employees of public institutions earn less than their private-sector counterparts. Even in studies that show the existence of a public-sector wage premium, much of the wage gap is attributed to the greater job security in the public sector, as represented by the relatively greater seniority of public-sector employees. Curiously, however, these studies do not provide an empirical analysis of job security, even though job security is one of the major reasons people prefer working in the public sector. As such, this study strives to provide an empirical analysis of the sectoral difference in job security. For we need to determine, empirically, whether the greater seniority of public-sector employees reflects the structural characteristics of public institutions themselves or individual idiosyncrasies. This study then turns its attention to the analysis of wage stability. The established literature focuses on demonstrating the empirical wage gap between the public and private sectors. However, by exploring how wages at public institutions are determined, we can find implications that the public sector provides greater wage stability than the private sector. According to Rah et al. (2010), the wage system of public institutions differs significantly from that of private businesses.[3] In civil service, the government, as the employer, decides the wage levels for its employees. Here, the government considers such policy issues as the inflation rate and the government's capacity for payment. Wage levels at public institutions may not be influenced by these considerations as much as in civil service, but the budget-handling ministries of the central government still tightly control the rate at which the total labor costs at these institutions may increase, and also decide the amount of performance incentives to be provided to each institution depending on how they rate on the government performance evaluation. Therefore, wage levels at public institutions are a matter more of policymaking than of market principles. This significant difference in the ways wage levels are determined in the public and private sectors likely affects the wage stability

3) Countless studies have been performed regarding how private businesses determine their wage levels. The mainstream theory is that the equilibrium wage is determined on the basis of the marginal productivity of labor. Marginal productivity of labor, in turn, is determined by the productivity of the given economy (including business cycle fluctuations), industry－or business－specific productivity, and the probable productivity of individual employees

of each sector in different ways as well. Employees take into account multiple factors when choosing where to work. If we confine our speculation to economic factors only, employees will prefer to work at the places offering higher wages than elsewhere. However, if an employee is risk-averse, he or she will be torn between a workplace with a higher wage but lower wage stability and the other with a lower wage but higher wage stability. Workplaces with low wage stability, therefore, can attract employees only by paying higher wages (i.e., "premiums") to encourage employees to take the risk. Faced with workplaces with low wage stability but offering the same level of wages as other workplaces with greater wage stability, risk-averse employees will choose the latter. When we apply this hypothesis to our comparison of public institutions and private businesses, we can infer that the latter will have to pay wage premiums to their employees in order to attract and retain them, as public institutions in general offer greater wage stability. If, however, the average wage levels of both types of workplaces are about the same, we can say that public institutions in fact pay wage premiums in the form of greater wage stability. In discussing the wage gap between the public and private sectors, we therefore need to consider not only the job security of each sector, but also the relative wage stability. However, much of the established literature focuses on the size of the wage gap without exploring the implications of wage stability. This study compensates for such shortcoming by providing an empirical analysis of the wage stability of each sector.

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Data

The central subject of this section is a series of surveys whose findings form the main set of data for our analysis: namely, Korean Labor and Income Panel Studies (KLIPSs) 1 through 13. The KLIPS is conducted annually on 5,000 households and their members living in urban areas in Korea. Between 1998 and 2010, a total of 13 KLIPSs were conducted, with each year's survey retaining at least 70 percent of the households used in the previous year's study, thereby ensuring a high degree of consistency and quality in the resulting panel data.

In general, the KLIPS data can be divided between household data and individual data providing information on household members aged 15 or older. The household data provide information on the generic facts of identification, household membership changes, family relations, exchange of economic resources between different generations, types of living arrangements, household income and spending, household assets and debts, and other household economic conditions. The individual data, on the other hand, provide information on the economic activity, income and spending behavior, education and occupational training, employment-related characteristics, work hours, job-seeking efforts, and labor market relocation records of individuals. The studies provide separate sections on the occupational histories of individuals, providing a retrospective glimpse into all the workplaces where individuals have been employed. These individual work histories provide detailed information on the types and sizes of workplaces, employment types, job starting and retiring dates, areas of occupation/profession, job titles or ranks, work hour arrangements, and earned

and other types of income of the surveyed individuals. This study uses these KLIPS work histories to analyze the job security and wage stability at public institutions and private businesses. The analyses of these two factors will be the main topics of discussion in Sections IV and V, respectively. In the following first subsection, we shall discuss the work histories and the information they provide in greater depth, as well as how the use of these records sets this study apart from other studies on similar topics. The second subsection will describe the process through which the empirical data for this study were processed, first by identifying how the major variables were identified and chosen, and then by explaining the sample selection method. This section will conclude by listing the basic statistics of the chosen sample.

1 KLIPS work history files[4]

The KLIPS work histories provide retrospective information on all the jobs that the surveyed individuals held prior to the first-ever KLIPS in 1998 as well as all the jobs that they have held since then. Furthermore, these records provide extensive data and information on all the jobs each individual has held since entering the labor market and the transitions and occupational changes that they have made over time. The main variables in these cumulative records are the job starting and retiring date, occupation and industry type, employment type or status, work hour arrangement, income pattern (including average monthly wages), workplace type and size, and others. Therefore, these work histories provide effective support for studies on labor market-wide phenomena, allowing researchers to identify individuals' paths of occupational transition and the changes in their wage levels.[5]

4) Much of the description of the KLIPS data in this section is based on "KLIPS 1 through 10 Survey Data: Codebook and User Guide," and the descriptions of the data, samples, and variables are directly quoted from the Codebook/User Guide

5) The KLIPS is modeled after the Panel Study of Income Dynamics (PSID) of the University of Michigan, which tracks the information on the individual members of 5,000 typical American households over a period of decades. However, the PSID, unlike the KLIPS, does not provide work histories or similar records. The work histories are rather similar to the "work history files" of the National Longitudinal

As the purpose of this study is to provide a comparative analysis of the wage levels at private businesses and public institutions, any data used in the analysis must sufficiently distinguish between the two sectors. The KLIPS work histories do provide information on workplace types (j501). The work histories provide 10 options for workplace type: i.e., (1) private and self-employed businesses; (2) foreigner-owned businesses; (3) government-invested or subsidized institutions and public-private consortia; (4) incorporated private foundations; (5) government organizations (e.g., civil service, the military, etc.); (6) freelancers; (7) nongovernmental and religious organizations; (9) other; and (10) unknown/unwilling to answer. As such, these records clearly distinguish between private and public workplaces as well as between civil service and public institutions, thus providing a perfect set of data for our purpose.[6)]

However, the KLIPS work histories do not provide information on the surveyed individuals' sex, age, educational attainment, and other information related to personal identity. Information on these matters is already provided as part of the KLIPS individual data. This study extracts these personal identity data from the KLIPS individual data and links them to the corresponding work histories using the personal identification code (PID) used in the KLIPSs. See the following section for more detailed explanations of the major variables, samples, and summary sample statistics used in the empirical analysis.

2 Variables and sample selection[7)]

This subsection explains the processes through which the major variables

Survey of Youth (NLSY), which gathered diverse types of data on young persons, aged 14 to 22, in the United States in 1979. Whereas the NLSY's records are confined to a certain age cohort only, the KLIPS provide work histories on all generations of household members

6) The size of the public institution employee sample also matters. Too small a number of samples in a given category may complicate the task of empirical analysis. See Subsection 2 for an explanation of the sizes of the samples included in or omitted from this study

7) Much of the description of the KLIPS data in this section is based on "KLIPS 1 through 10 Survey Data: Codebook and User Guide." The descriptions of the data, samples, and variables are directly quoted from the Codebook/User Guide

and samples used in the empirical analysis were identified and selected. Regarding variables, we need to distinguish between variables of personal identity and variables of work histories.

A. Variables

The variables of personal identity used in this study are sex, age, and educational attainments. The KLIPS data on the sex of surveyed individuals were used directly, while the ages of those individuals had to be calculated separately according to the dates of birth provided in the KLIPS data. The information on the educational attainments of these individuals, provided in each year's KLIPS, was also used and divided into four stages: less than high school (<12), high school graduate (=12), vocational college graduate and college dropout (13-15), and college graduate and beyond (>=16). The final educational attainments of surveyed individuals were determined according to the KLIPS personal data on academic backgrounds (p0110)[8] and graduate status (p0111).[9]

The variables indicating economic activity, such as workplace type and size, seniority level by workplace, duration of unemployment, and wage levels, were extracted from the KLIPS work histories and processed additionally for analysis. The workplace types, provided in j501, were again processed and divided into two: private businesses and public institutions. The KLIPS work histories provide 10 options for workplace type. Of these, the government-invested/subsidized institutions and public-private consortia were re-labeled as "public institutions," while private businesses and foreigner-owned businesses were re-labeled as "private businesses."

Private businesses and public institutions diverge significantly in terms of industry, occupation type, and size. Kim et al. (2000), in analyzing the supposed wage gap between the public and private sectors, emphasizes the

8) The KLIPS individual data provide nine options for academic background (p0110): (1) preschool; (2) unschooled; (3) elementary school; (4) middle school; (5) high school; (6) vocational (two-year) college; (7) four-year college; (8) graduate school/master's degree; and (9) graduate school/ octorate

9) The KLIPS individual data provide five options for graduate status: (1) graduated; (2) completed; (3) dropout; (4) enrolled; and (5) on leave of absence

importance of properly defining the scope and range of the private sector to be analyzed. Lim et al. (2007), therefore, include only private businesses employing 100 persons or more as comparable counterparts to public-sector workplaces. Rah et al. (2013) also treats workplace size as an independent variable for direct control. These and numerous other studies also point out the significant difference among private-sector industries and businesses, suggesting that the related variables be directly controlled. In recognition of the fact that seniority and wage level may be dependent on workplace size, this study also explicitly discusses workplace size (j504)[10] in its empirical analysis, and uses dummy variables for industry/occupation type for direct control in the regression analysis. For the specific industry and occupation classifications used in the regression analysis, please see the Appendix. Seniority is defined as the number of months between the dates on which one starts and retires from a given job.[11] The months are then divided by 12 in order to express seniority in years. The KLIPS data provide information on diverse types of earned income, including hourly pay (j307), daily pay (j306), weekly pay (j305), monthly pay (j304), and annual salary (j303). This study combines the basic wage and bonuses/incentives to calculate the annual earned income, and divides it by 12 to obtain the average monthly wage (j316). Cho (1998), Heo et al. (2007), and Lim et al (2009) use single-year cross-sectional data to analyze the supposed public-private wage gap. In such analyses, there is no need to distinguish between nominal wage and real wage. As this study concerns data from multiple years, however, we convert the nominal wage of each year into a real wage using the 2005 Consumer Price Index. Finally, we need to discuss the length of one's stay in the labor market. This concept differs from the concept of seniority at a given workplace. The theory of human capital explains the difference as follows. One enters the labor market and comes to acquire an increasing amount

10) There are 10 options for workplace size (j504): (1) one to four employees; (2) five to nine employees; (3) 10 to 29 employees; (4) 30 to 49 employees; (5) 50 to 69 employees; (6) 70 to 99 employees; (7) 100 to 299 employees; (8) 300 to 499 employees; (9) 500 to 999 employees; and (10) 1,000 employees or more. This study re-sorted these options into four categories: (1) one to 29 employees; (2) 30 to 99 employees; (3) 100 to 499 employees; and (4) 500 employees or more

11) The job starting date consists of the starting year (j001) and month (j002), and the retiring date consists of the retiring year (j010) and month (j012)

of human capital through the learning-by-doing process entailed in one's supply of labor. The human capital one thus acquires is reflected in one's wage level. Therefore, the longer one stays in the job market, the higher one's wage level becomes. Seniority and the length of stay in the labor market play different roles in the accumulation of human capital. Seniority represents how long one has worked at a specific workplace and, therefore, limits one's human capital to that workplace only. The length of stay in the labor market, on the other hand, leads to human capital irrespective of the workplace where one happens to be working at a given time. Therefore, we may divide the human capital associated with these two concepts into firm-specific human capital and general human capital. Firm-specific human capital disappears completely when one moves from one workplace to another, but general human capital remains intact. Also, recent studies focus on industry-specific and occupation-specific human capital, as people who move from one workplace to another but stay within the same line of work will retain these types of human capital irrespective of the firms at which they choose to work. Based on this trend, this study treats the length of one's stay in the labor market as a variable in its own right, separate from the variable of seniority. Using the KLIPS work histories and individual data, we can define and measure the length of stay in the labor market in diverse ways. The work histories provide the dates on which the surveyed individuals started working at each given workplace. Therefore, the date on which an individual entered his or her first-ever workplace can be equated with the date on which he or she entered the labor market for the first time in his or her life. The KLIPS individual data, on the other hand, provide information on the status of each surveyed individual's educational attainment and graduation/enrollment status each year. If we define the date of one's joining the labor market as the date one completed his or her education, we may also estimate the length of one's stay in the labor market using that date. However, this study uses the job-starting date of each individual's first-ever workplace as the starting date of that individual's stay in the job market. For there are individuals who continue studying after gaining employment or who quit their job after some time to return to school, thus making it impossible for this study to use the labor-market information they have accumulated prior to the completion of their education.

B. Sample selection

The 13th and final KLIPS included in this study was conducted in 2010.[12] For panel data, it is extremely important to retain the same number of samples from year to year. On average, the KLIPS data retain 75 percent of the previous year's samples from year to year. The first KLIPS, conducted in 1998, concerned 5,000 households with 17,505 members in total. Of these members, 13,738 were aged 15 or older and 13,317 participated in the actual interviews. The second KLIPS, conducted the following year, re-interviewed 85 percent of the household members aged 15 or over that had been surveyed the previous year. Beginning in the third year, the KLIPS researchers re-surveyed the original sample households and surveyed new households simultaneously.[13] The cumulative total of household members surveyed in the 13 KLIPSs is 21,609.[14] This study limits its scope to working-age household members only, aged between 15 and 64. Also, household members without consistent educational records and employment ID numbers were excluded from the analysis. The final number of household members thus analyzed is 7,003 out of 34,373 observed samples. This study also confines its scope to full-time workers and workers with employment contracts for at least one year of service each. Samples with incomplete information on workplace type, size, industry/occupation type, seniority level, and wage level were also omitted from the analysis. In the end, 5,262 household members out of 25,069 observed samples were analyzed.

12) This study began in March, when data only up to the 13th KLIPS, conducted in 2010, were available. As of December 2014, the Korea Labor Institute provided data up to the 15th KLIPS, which was conducted in 2012. The additional data from the later two years should be included in future research

13) "New household members" refers to the individuals newly included in a given year' s KLIPS and not in the previous years'. They include people who reached the age of 15 in a given year, people who were not included in the KLIPS–surveyed households until the previous year, or people who were included in the survey for the first time in their own right in a given year, having gained independence from previous households

14) For the total number of households, the number of original household members, and the number of new household members in each year's KLIPS, see the Appendix

〈Table III-1〉 **Summary Statistics**

	Total	Private businesses	Public institutions
N	25069	23435	1634
(%)	100	93.5	6.5
Sex (%)			
Male	65.2	64.7	72
Female	34.8	35.3	28
Education (%)			
Less than high school	15.2	15.8	6.3
High school graduate	36.6	37.8	18.7
Vocational college graduate	21.4	21.4	21.2
College graduate and beyond	26.8	25	53.7
Age (years)			
Average	37.3	37.2	38.3
Standard deviation	9.8	9.8	9
Length of stay in labor market (years)			
Average	8.8	8.5	12.2
Standard deviation	6.3	6.1	7.8
Seniority (years)			
Average	6.7	6.4	11
Standard deviation	6.2	5.9	7.9
Real wage (in KRW 10,000)			
Average	179.9	175.4	245.3
Standard deviation	113.3	111.2	123.2
Workplace size (employees)			
1 to 29	29.1	30.6	6.7
30 to 99	20	20.5	13
100 to 500	18.6	18.7	15.8
500 or more	32.3	30.1	64.5

<Table III-1> provides a summary of the statistics on all the samples included in the empirical analysis of this study. It shows that both public institutions and private businesses hire more men than women, but that the ratio is higher by seven percentage points in public institutions. There is also a clear gap in the educational attainment of employees. Whereas high-school and college graduates (and beyond) make up 37 percent and 27 percent, respectively, of employees at private businesses, high-school graduates make up only 19 percent and college graduates (and beyond) occupy 54 percent of employees at public institutions. Also, employees of public institutions are, on average, one year older than their private-business counterparts, but possess stays in the labor market 3.5 years longer, almost 1.5 times the average length of that of private-business employees. Similarly, employees at public institutions also possess about 4.5 years more (1.7 times) in terms of seniority than their private-business counterparts. The number of years of seniority, unlike the length of stay in the labor market, indicates how long one has worked at a single given workplace. One may have stayed in the labor market for a long time, but may also have frequently moved between jobs. One's seniority, however, serves as an indicator of the relative job security one has at one's workplace. Nevertheless, we should not equate the relatively greater seniority of public-institution employees with their job security without an in-depth empirical analysis. The real wage at public institutions is also about 36 percent higher than that at private businesses. This wage gap appears to support the claim that public institutions do provide wage premiums. In the meantime, public institutions are also far more likely to be larger in size than private businesses. About 65 percent of public institutions hire 500 persons or more each, in contrast to the 32 percent among private institutions. In general, the larger a workplace is, the higher the wage level and the greater seniority the employees possess. Therefore, on the basis of these statistics alone, we cannot determine whether the wage premiums offered by public institutions are inherent to their sizes or reflect conscious policy decisions. In the following section, we carry out an econometric analysis to determine whether such wage premiums do indeed exist.

The summary statistics indicate that the levels of job security and wages do appear to be higher at public institutions than at private businesses. However, in general, employees at public institutions possess greater quantities of factors

that lead to higher wages and greater job security, such as educational attainments, lengths of stay in the labor market, and sizes of workplaces. In order to determine how much more secure the jobs are and how much higher and more stable the wages are at public institutions than at private businesses, we need a more elaborate and in-depth empirical analysis. In Sections IV, V, and VI, we employ diverse methods of empirical analysis to explore the public-private gaps in job security and wage level.

Ⅳ

Wage Gap between Public Institutions and Private Businesses

This section provides an analysis of the KLIPS data that empirically demonstrates whether there is really a wage gap between public institutions and private businesses in Korea. First, a single wage equation model is used, under the hypothesis that public institutions and private businesses reward their employees at the same rate, so as to determine how large the wage gap will be when the dummy variable for public institutions are used. Next, a fixed-effects analysis is performed to control for heterogeneity among individual employees that is not easily observed. Finally, under the hypothesis that public institutions and private businesses reward individual employees with different idiosyncrasies at different rates, a sector-by-sector wage equation model is used. The findings of this model are decomposed to discover the true causes and factors of the wage gap.

1 Single wage equation model

The following single wage equation can be used to estimate how large the wage premiums are at public institutions.

$$\ln W_{i,j,t} = X_{i,t}\beta + Z_{j,t}\alpha + D_{Public\ Institution}\gamma + u_{i,j,t}$$

〈Table IV-1〉 **Log Wage Regression Analysis: OLS**

	(1)	(2)	(3)	(4)	(5)
Public institutions	0.044*	0.044*	0.003	0.006	0.009
	(0.020)	(0.019)	(0.019)	(0.018)	(0.018)
Women	−0.363**	−0.395**	−0.370**	−0.399**	−0.402**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Less than high school (〈12)	−0.247**	−0.206**	−0.219**	−0.182**	−0.178**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Vocational college graduate (13∼15)	0.113**	0.066**	0.104**	0.055**	0.045**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
College graduate and beyond (〉=16)	0.391**	0.296**	0.364**	0.269**	0.258**
	(0.013)	(0.014)	(0.013)	(0.014)	(0.014)
Length of stay in labor market	0.044**	0.045**	0.047**	0.048**	0.040**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Square of length of stay in labor market	−0.001	−0.001	−0.001	−0.001*	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Seniority	0.019**	0.018**	0.015**	0.014**	0.016**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Square of seniority	−0.000	−0.000	−0.000	−0.000	−0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Industry/occupation type	N	Y	N	Y	Y
Workplace size	N	N	Y	Y	Y
Unemployment rate	N	N	N	N	Y
N	25069	25069	25069	25069	25069

Notes: 1) *p 〈 0.05, ** p 〈 0.01
2) Figures in parentheses indicate standard deviations

$W_{i,j,t}$ indicates the amount of wage the individual i receives for working at either a public institution or a private business at time t. $X_{i,t}$ represents the vectors indicative of individual employees idiosyncrasies, such as sex, length of stay in the labor market, educational attainments, and seniority. $Z_{i,t}$ stands for the vectors indicative of the idiosyncrasies of workplaces, such as size and industry type. $D_{Public\ Institution}$ is a dummy variable that equals one (1) for public

institutions and zero (0) for private businesses. Therefore, γ stands for the wage gap between public institution and private business employees. When positive, it indicates that the wage level of public institution employees is higher than that of their private business counterparts.

<Table IV-1> shows the estimates obtained using the single wage equation and the least squares method. The individual idiosyncrasies considered in this model are sex, educational attainments, length of stay in the labor market and its square, and seniority and its square. As for sex, a dummy variable of one (1) was used for women. The educational attainments were divided into four levels—that is, less than high school, high school graduate, vocational college graduate, and college graduate and beyond—using the dummy variable for the fourth. Both the length of stay in the labor market and seniority were measured in years. The constants, therefore, indicate the wage level a male high-school graduate receives upon entering the labor market for the first time. Workplace characteristics can also influence wage level, so workplace size, industry type, and occupation type were controlled. Finally, the influence of business cycle fluctuations on wages was taken into account by including the total unemployment rate of the given year in the regression formula.[15] Column (1) of <Table VI> lists wage estimates that were obtained without taking into account workplace characteristics and business cycle fluctuations. Industry and occupation types were considered with respect to the estimates in Column (2), and only workplace size was controlled with respect to the estimates in Column (3). Column (4) lists estimates obtained by controlling industry/occupation type as well as workplace size, while Column (5) lists estimates obtained by controlling all of these factors in addition to the total unemployment rate.

Considering the estimates corresponding to individual idiosyncrasies, women in general earn 40 percent less than men. In other words, the gender gap persists in the Korean job market. Furthermore, the higher one's educational attainments, the greater one's wage. With workplace and business cycle

15) We may use year dummies to control the business cycle fluctuations from year to year. This study, however, uses the total unemployment rate of each given year instead. The findings of a regression analysis using year dummies would not differ qualitatively from the findings of the analysis using the total unemployment rate

characteristics not controlled, college graduates and beyond appear to receive wages 39 percent higher than those of high school graduates. When industry type, occupation type, and workplace size are controlled, however, this wage gap drops to 27 percent. This is either because college graduates and beyond work in industries or occupations offering greater wages or at larger workplaces. When business cycles are controlled, the wage gap further narrows to 26 percent, because either college graduates and beyond work in areas less susceptible to business cycle fluctuations or enjoy greater job security than their less-educated counterparts.[16] The length of stay in the labor market and seniority, on the other hand, affect wage levels in an inverse-U shape, as already shown in the literature on labor economics. This indicates that one's wage level generally continues to increase until it reaches a peak 25 years into the labor market, after which it begins to decline. An interesting phenomenon is that the rise in the wage level as the length of stay in the labor market increases is more abrupt than the rise in the wage level with increasing seniority. We may interpret this as indicating that, in the labor market, general human capital tends to be valued more highly than firm-specific human capital.

Now, let us return to the supposed wage gap. The summary statistics show that public institutions offer 36 percent more in wage premiums than private businesses.[17] However, public institution employees are also better-educated, have stayed longer in the labor market, and possess greater seniority than their private business counterparts. Therefore, we cannot determine at this stage whether the apparent wage premiums reflect these individual idiosyncrasies or something structural about public institutions. Column (1), which lists estimates that were obtained by controlling individual idiosyncrasies, shows that the wage level at public institutions is about 4.4 percent higher than that at private businesses, thus suggesting that much of the supposed wage premiums at public

16) In order to determine the true causes of this gap, we will need to analyze, in depth, the elasticity of high-school and college graduates' respective wage and job security levels to business cycle fluctuations. However, such analyses do not serve the purpose of this report, and are therefore not discussed herein

17) The size of wage premiums based on the KLIPS analysis is similar to the size of wage premiums identified by Jeon (2014)

institutions (about 88 percent) in fact result from individual differences. In other words, public institutions do not provide higher wages for all employees than do private businesses, but merely employ more people with greater human capital than do private businesses. Columns (2) and (3), controlling industry and occupation types and workplace size, respectively, reveal that industry/occupation type does not affect the supposed wage premiums, while workplace size does. In other words, when the differing sizes of workplaces are controlled, the apparent wage premiums disappear. This means that the seemingly higher wage level at public institutions reflects both the idiosyncrasies of public institution employees as well as the workplace sizes of these institutions. Finally, the public institution wage premiums disappear yet again when we control business cycle fluctuations. Therefore, employees with similar amounts of human capital, in the same line of work (industry- or occupation-wise), and working at workplaces of similar sizes earn similar wages whether they work at public institutions or at private businesses. This finding confirms the conclusions reached by Rah et al. (2013) and Jeon (2014).

2 Fixed-effects analysis

The single wage equation model reveals that much of the apparent wage gap between public institutions and private businesses reflects differences in individual employees. From this fact, we may infer that factors associated with high levels of human capital, but not directly observable by the researcher (e.g., individuals' intelligence quotients), may also play a role in the appearance of public institution wage premiums. If these fixed effects are correlated to educational attainments, the length of stay in the labor market, and/or employment at public institutions, they may cause biases in the estimates of these variables if not controlled. There is a dearth of studies analyzing wage premiums by controlling these unobserved forms of heterogeneity. Most of the existing studies employ wage equations on cross-sectional data of a single year, and therefore, fail to identify and control the unobserved abilities of individual employees. The panel structure of the KLIPS work histories, however, provides information on each surveyed individual across multiple years. This allows us

to control unobserved heterogeneity by applying a fixed-effects regression formula. We may, therefore, alter our single wage equation as follows:

$$\ln W_{i,j,t} = X_{i,t}\beta + Z_{j,t}\alpha + D_{Public\ Institution}\gamma + \mu_i + \epsilon_{i,j,t}$$

This expresses the unobserved characteristics of individual employees that affect employees' job competency and wage levels, but that are not directly observable by the researcher. The purpose of our fixed-effects analysis is to determine whether public institution wage premiums persist even when these unobserved abilities of employees are controlled. As the fixed-effects analysis entails introducing additional individual-by-individual dummies, all variables of individual idiosyncrasies (e.g., sex and final educational attainment levels) that do not change over time are naturally eliminated. The KLIPSs, however, do include individuals who go on to attain higher educational degrees while working in the labor market. Therefore, educational attainments are included in our fixed-effects regression analysis. Public institution dummy variables can also be treated as fixed-effects variables, such as employees' sex. If, for instance, an individual began working at a public institution and does not move to the private sector, the public institution effect will remain intact. The KLIPS work histories, however, do show samples moving from one sector to the other over time. It is these samples that help us estimate public institution wage premiums, even in this fixed-effects analysis.

<Table IV-2> lists the estimates obtained by a fixed-effects analysis using the single wage equation. As in Table <IV-1>, Column (1) of <Table IV-2> lists estimates that were obtained without controlling workplace characteristics. Columns (2) and (3), on the other hand, show estimates that were obtained by controlling industry/occupation type and workplace size, respectively. Column (4) shows the estimates that were obtained by controlling all workplace characteristics, while Column (5) shows the estimates that were obtained by controlling not only workplace characteristics but also the total unemployment rate of each given year. How does the public institution dummy, which represents public institution wage premiums, change across these columns? First of all, Column (1) shows that the dummy lacks any statistical significance (unlike its

〈Table IV-2〉 **Log Wage Regression Analysis: Fixed Effect**

	(1)	(2)	(3)	(4)	(5)
Public institutions	−0.038	−0.017	−0.052	−0.032	−0.031
	(0.032)	(0.031)	(0.032)	(0.031)	(0.031)
Less than high school (〈12)	−0.092	−0.091	−0.093	−0.092	−0.087
	(0.048)	(0.050)	(0.050)	(0.052)	(0.052)
Vocational college graduate (13~15)	0.057*	0.059*	0.059*	0.061*	0.059*
	(0.029)	(0.028)	(0.028)	(0.028)	(0.028)
College graduate and beyond (〉=16)	0.141**	0.142**	0.140**	0.141**	0.141**
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
Length of stay in labor market	0.074**	0.074**	0.073**	0.073**	0.070**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Square of length of stay in labor market	−0.002**	−0.002**	−0.002**	−0.002**	−0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Seniority	−0.016**	−0.017**	−0.016**	−0.016**	−0.016**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Square of seniority	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry/occupation type	N	Y	N	Y	Y
Workplace size	N	N	Y	Y	Y
Unemployment rate	N	N	N	N	Y
N	25069	25069	25069	25069	25069

Notes: 1) *p 〈 0.05, ** p 〈 0.01
2) Figures in parentheses indicate standard deviations

counterpart in <Table IV-1>). Once the unobserved heterogeneity of individual employees is controlled, the wage premiums disappear. In other words, this indicates that the wage level at public institutions appears high because their employees possess relatively greater amounts of unobservable human capital. Even when the workplace characteristics and business cycle fluctuations are

controlled, the coefficients of the public institution dummy do not become statistically significant. The coefficients for college graduates and beyond are lower than the coefficients obtained by applying the least squares method, indicating that the fixed effect bears a positive correlation to individual employees' educational attainments.[18)]

3 By-sector wage equation: estimates and decomposition

As already mentioned in Section II, the single wage equation method presupposes an identical rate of return for both private businesses and public institutions. However, the two sectors may, in fact, apply different rates of return. Therefore, we need to analyze and determine whether the supposed wage gap between the two sectors reflects the differing rates of return or other characteristics, such as employees' idiosyncrasies. To this end, we employ two different wage equations for the two sectors.

18) Neither 〈Table IV–1〉 nor 〈Table IV–2〉 provides estimates of workplace size. See the table below for the estimates involving different workplace sizes.

	Basic analysis			Fixed–effects analysis		
	(3)	(4)	(5)	(3)	(4)	(5)
One to 29 employees	–0.2078** (0.0118)	–0.1998** (0.0117)	–0.2018** (0.0117)	–0.0944** (0.0122)	–0.0900** (0.0120)	–0.0902** (0.0120)
30 to 99 employees	–0.1676** (0.0119)	–0.1528** (0.0117)	–0.1541** (0.0117)	–0.0622** (0.0107)	–0.0599** (0.0108)	–0.0600** (0.0108)
100 to 499 employees	–0.1241** (0.0120)	–0.1091** (0.0115)	–0.1099** (0.0115)	–0.0245** (0.0090)	–0.0235** (0.0090)	–0.0234** (0.0090)

Notes: 1) *p 〈 0.05, ** p 〈 0.01, 2) Figures in parentheses indicate standard deviations

The coefficients reflecting workplace size also show that the wage gap diminishes along the fixed effect, suggesting that individuals with greater human capital are more likely to work in larger workplaces offering higher wages

$$\ln W_{i,\,Public\ \ Institution,\,t} = X_{i,t}\beta^{Public\ \ Institution} + Z_{Public\ \ Institution,\,t}\alpha^{Public\ \ Institution} + \epsilon_{i,\,Public\ \ Institution,\,t}$$

$$\ln W_{i,\,Public\ \ Institution,\,t} = X_{i,t}\beta^{Public\ \ Institution} + Z_{Public\ \ Institution,\,t}\alpha^{Public\ \ Institution} + \epsilon_{i,\,Public\ \ Institution,\,t}$$

As we are using different wage equations for public institutions and private businesses, we no longer need to employ the public institution dummy we used in the single wage equation model. The two equations presuppose different rates of return (β) for public institutions and private businesses. Here, the wage gap is analyzed by estimating the wages employees of similar characteristics and qualifications would earn by working at public institutions and private businesses. This will allow us to decompose the factors that contribute to the wage gap, thus determining whether it results from the different rates of return or from the idiosyncrasies of employees. The chosen method of decomposition is the one most commonly used: the Oaxaca method. This method involves decomposing the wage function for each sector into the differences between employees and between the rates of return of the two sectors. The log average wage for each sector can therefore be expressed as follows:

$$\overline{\ln W^{j}} = \hat{\beta}^{j}\overline{X}^{j} \quad j = Public\ \ Institution,\ \ Private\ \ Business$$

Using this, we may express the wage gap between public institutions and private businesses as follows:

$$\triangle W^{Public\ \ Institution} \equiv \overline{\ln W}^{Public\ \ Institution} - \overline{\ln W}^{Private\ \ Business} =$$

$$\hat{\beta}^{Public\ \ Institution}\overline{X}^{Public\ \ Institution} - \hat{\beta}^{Private\ \ Business}\overline{X}^{Private\ \ Business}$$

Remove $\hat{\beta}^{\ the\ \ whole} = (\overline{X}^{\ Public\ \ Institution} - \overline{X}^{\ Private\ \ Business})$ from the equation above and break it down to obtain the following decomposition equation:

$$\triangle W^{the\ \ whole} = \hat{\beta}^{Public\ \ Institution}\overline{X}^{Public\ \ Institution} - \hat{\beta}^{Private\ \ Business}\overline{X}^{\ Private\ \ Business}$$

$$= (\hat{\beta}^{Public\ \ Institution} - \hat{\beta}^{the\ \ whole})\overline{X}^{\ Public\ \ Institution} - (\hat{\beta}^{Private\ \ Business} - \hat{\beta}^{the\ \ whole})\overline{X}^{Private\ \ Business}$$

$$+ \beta^{the\ \ whole}(\overline{X}^{\ Public\ \ Institution} - \overline{X}^{\ Private\ \ Business})$$

In this decomposition equation, the second line expresses the wage gap resulting from the different rates of return, while the third line expresses the wage gap resulting from employee idiosyncrasies at an identical rate of reward.[19)]

Earlier studies decompose wage gap factors using only aggregate statistics. However, considering that employee idiosyncrasies form vectors, we can also analyze how each idiosyncrasy affects the wage gap. To this end, this study divides employee idiosyncrasies into sex, educational attainments, length of stay in the labor market, and seniority and determines how each factor affects the wage gap. This is shown by the equations below.

$$\triangle W^{Public\ Institution} = \triangle W_{sex}^{Public\ Institution} +$$

$$\triangle W_{education\ attainments}^{Public\ Institution} + \triangle W_{length\ of\ stay\ in\ the\ labor\ market}^{Public\ Institution} + \triangle W_{seniority}^{Public\ Institution}$$

$$\triangle W_k^{Public\ Institution} = \left(\hat{\beta}_k^{Public\ Institution} - \hat{\beta}_k^{the\ whole}\right)\overline{X}_k^{Public\ Institution} -$$

$$\left(\hat{\beta}_k^{Private\ Business} - \hat{\beta}_k^{the\ whole}\right)\overline{X}_k^{Private\ Business} + \hat{\beta}_k^{the\ whole}\left(\overline{X}_k^{Public\ Institution} - \overline{X}_k^{Private\ Business}\right)$$

The goal is to determine how factor k affects the overall wage gap, and how the different rates of return and other factors influence k.

A. By-sector wage equation estimates

<Table IV-3> lists separate wage equation estimates for private businesses and public institutions. The first two columns list the estimates that were obtained without controlling industry/occupation type, workplace size, total unemployment rate, and the like. Industry/occupation type and workplace size were controlled for the estimates in the next two columns. These factors as well as the total unemployment rate were controlled in the last two columns.

19) The rate of reward applied here is identical to the rate of reward used in the wage function of the single wage equation.

〈Table IV-3〉 **Log Wages by Sector**

	Private businesses	Public institutions	Private businesses	Public institutions	Private businesses	Public institutions
Women	−0.367**	−0.311**	−0.405**	−0.300**	−0.408**	−0.305**
	(0.011)	(0.041)	(0.011)	(0.041)	(0.011)	(0.041)
Less than high school	−0.245**	−0.292**	−0.181**	−0.202*	−0.177**	−0.203*
	(0.016)	(0.089)	(0.016)	(0.079)	(0.016)	(0.079)
Vocational college graduate	0.110**	0.159**	0.053**	0.085	0.043**	0.065
	(0.014)	(0.060)	(0.013)	(0.051)	(0.013)	(0.050)
College graduate and beyond	0.391**	0.389**	0.268**	0.278**	0.258**	0.252**
	(0.014)	(0.059)	(0.015)	(0.053)	(0.014)	(0.052)
Length of stay in labor market	0.045**	−0.014	0.048**	0.007	0.041**	−0.006
	(0.006)	(0.029)	(0.006)	(0.022)	(0.006)	(0.022)
Square of length of stay in labor market	−0.001	0.004*	−0.001*	0.003	−0.001	0.004*
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Seniority	0.019**	0.075**	0.016**	0.054**	0.017**	0.063**
	(0.006)	(0.025)	(0.005)	(0.019)	(0.005)	(0.019)
Square of seniority	−0.000	−0.005*	−0.001	−0.004*	−0.000	−0.004**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)
Constants	4.679**	4.642**	4.781**	4.561**	5.005**	4.970**
	(0.016)	(0.068)	(0.019)	(0.095)	(0.026)	(0.116)
Industry / occupation type	N	N	Y	Y	Y	Y
Workplace size	N	N	Y	Y	Y	Y
Unemployment rate	N	N	N	N	Y	Y
N	23435	1634	23435	1634	23435	1634

Notes: 1) *p 〈 0.05, ** p 〈 0.01
2) Figures in parentheses indicate standard deviations

The rates of return differ in response to employee idiosyncrasies. For instance, the wage gap between men and women is greater at private businesses than at public institutions, with statistical significance. This likely reflects the diverse anti-discrimination and pro-women policies that the government has enforced at public institutions. Next, private businesses offer a higher rate of

return for employees who are less than high-school graduates, while public institutions offer a higher rate of return for employees with college or postgraduate degrees. Nevertheless, the rates of return between the two sectors do not differ with any statistical significance in terms of educational attainments. On the other hand, there is a clear and significant gap between the two sectors with respect to the rates of return for the length of stay in the labor market and seniority. The rate of return for employees of private businesses that have stayed in the labor market longer is about three times greater than the rate of return for employees with greater seniority. In other words, private businesses value general human capital much more highly than firm-specific human capital, which may explain the high employee turnover rates among private businesses. However, we need a more in-depth analysis to determine whether such high turnover rates are indeed caused by the greater reward for general human capital than firm-specific human capital. By contrast, the pattern is reversed at public institutions, which reward seniority much more highly than the length of stay in the labor market. As a matter of fact, public institutions do not appear to provide any specific incentives or rewards for the length of one's stay in the labor market, perhaps indicating that public institutions value firm-specific human capital much more highly than general human capital. This may reflect the particular nature of tasks in general at public institutions or the fact that the skills and qualities valued highly by public institutions are not so readily applicable to private businesses. Alternatively, this phenomenon may reflect not the particularities of the tasks and valued skills at public institutions, but the rigid system of seniority-based wage increases. Whereas private businesses determine wages and rewards for employees on the basis of labor productivity rather than mere seniority, public institutions increase wages and rewards for employees according to seniority first and productivity second.

B. Decomposition results

Before discussing the decomposition results in depth, let us first look at <Table IV-4>, which lists the averages of the by-sector wage equation estimates and employee idiosyncrasies. These estimates are identical to those listed in the third column—obtained by controlling industry/occupation type and

the total unemployment rate—in <Table IV-3>.

Women make up 35 percent of employees at private businesses and only 28 percent at public institutions. However, women at public institutions earn about 10 percent more than their counterparts at private businesses. Therefore, the sex-dependent wage gap can be explained as a matter of differing rates of return rather than of individual differences. On the other hand, although the ratio of college graduates and beyond at public institutions is more than double that at private businesses, the wage level of college graduates and beyond at public institutions is slightly lower than that of their counterparts at private businesses. As such, the supposed wage gap between the public and private sectors with respect to employees' educational attainments reflects individual differences more than the structurally different rates of return. Also, employees at public institutions have spent about 1.5 times longer in the labor market than their counterparts at private businesses. However, private businesses offer much greater rewards for the length of stay in the labor market than do public institutions. Therefore, the wage gap dependent on the length of stay in the labor market can be explained in terms of individual differences. On the contrary, employees at public institutions possess about 1.5 times greater seniority than their counterparts at private businesses and also receive rewards at a rate about 3.7 times higher than that of their counterparts at private businesses. Therefore, the seniority-dependent wage gap can be explained in terms of both individual differences and the different rates of return. Now, let us turn to our decomposition model and how each of these factors contributes to the supposed wage gap between the public and private sectors. See <Table IV-5>.

The first row of <Table IV-5> lists the wage gap between public institutions and private businesses. Public institutions appear to offer a 47-percent wage premium. The decomposition of this wage gap by individual factors and rate of return reveals that approximately 70 percent of this wage gap is caused by the differences in the types and qualifications of employees. Seniority is by far the most important factor when it comes to explaining the wage gap between public institutions and private businesses, followed by educational attainments (i.e., college degrees and beyond) and sex (i.e., women). The length of stay in the labor market, on the other hand, serves to narrow the wage gap between the two sectors. The decomposition method was also used to determine

〈Table IV-4〉 **By-Sector Log Wage Function Estimates and Employee Idiosyncrasies: Averages**

	By–sector wage function estimates			By–sector employee idiosyncrasies		
	Overall	Private businesses	Public institutions	Overall	Private businesses	Public institutions
Women	−0.403**	−0.408**	−0.305**	0.3480	0.3530	0.2800
	(0.011)	(0.011)	(0.041)			
Less than high school	−0.178**	−0.177**	−0.203*	0.1520	0.1580	0.0630
	(0.016)	(0.016)	(0.079)			
Vocational college graduate	0.045**	0.043**	0.065	0.2140	0.2140	0.2120
	(0.013)	(0.013)	(0.050)			
College graduate and beyond	0.259**	0.258**	0.252**	0.2680	0.2500	0.5370
	(0.014)	(0.014)	(0.052)			
Length of stay in labor market	0.040**	0.041**	−0.006	8.8000	8.5000	12.2000
	(0.006)	(0.006)	(0.022)			
Square of length of stay in labor market	−0.001	−0.001	0.004*	77.4400	72.2500	148.8400
	(0.000)	(0.001)	(0.002)			
Seniority	0.016**	0.017**	0.063**	6.7000	6.4000	11.0000
	(0.005)	(0.005)	(0.019)			
Square of seniority	−0.000	−0.000	−0.004**	44.8900	40.9600	121.0000
	(0.000)	(0.000)	(0.001)			
One to 29 employees	−0.202**	−0.205**	−0.190**	0.2910	0.3060	0.0670
	(0.012)	(0.012)	(0.053)			
30 to 99 employees	−0.155**	−0.155**	−0.189**	0.2000	0.2050	0.1300
	(0.012)	(0.012)	(0.046)			
100 to 499 employees	−0.110**	−0.114**	−0.052	0.1860	0.1870	0.1580
	(0.011)	(0.012)	(0.032)			
Constants	5.009**	5.005**	4.970**			
	(0.025)	(0.026)	(0.116)			
N	25069	23435	1634	25069	23435	1634

Notes: 1) *p 〈 0.05, ** p 〈 0.01
2) Figures in parentheses indicate standard deviations
3) Industry/occupation type and total unemployment rate have been controlled

the respective contributions of the different rates of return and individual differences to the wage gap. As for sex, both the rate of return and the sex play about equal parts (50/50), as public institutions offer a higher rate of return for women employees than do private businesses, but hire fewer women. Regard ing educational attainments, the educational background of individual employees accounts for 105 percent of the wage gap as public institutions, while rewarding

〈Table IV-5〉 **Decomposition of Factors Contributing to the Public-Private Wage Gap**

	Factor-specific contribution		Rate of return contribution		Factor contribution	
	Level	Ratio (%)1)	Level	Ratio (%)2)	Level	Ratio (%)2)
Overall	0.468	9.053)	0.1399	29.88	0.3195	69.55
Women	0.059	12.55	0.0294	49.66	0.0298	50.34
Less than high school graduate	0.015	3.25	-0.0017	-11.42	0.0169	111.42
Vocational college graduate	0.005	0.98	0.0047	101.88	-0.0001	-1.88
College and beyond graduate	0.071	15.09	-0.0037	-5.29	0.0741	105.29
Length of stay in labor market	-0.427	-91.18	-0.5764	135.60	0.1513	-35.60
Squares of length of stay in labor market	0.601	128.41	0.6549	108.92	-0.0536	-8.92
Seniority	0.585	125.04	0.5128	86.90	0.0773	13.10
Square of seniority	-0.476	-101.58	-0.4516	91.86	-0.0400	8.14
One to 29 employees	0.050	10.67	0.0015	3.07	0.0489	96.93
30 to 99 employees	0.007	1.54	-0.0044	-60.97	0.0116	160.97
100 to 499 employees	0.013	2.80	0.0099	74.92	0.0033	25.08
Constants	-0.035	-7.56	-0.0354	100.00	0.0000	0.00

Notes: 1) How each factor contributes to the overall wage premium
2) The respective makeup of the different rates of return and factors in the factor-specific contributions
3) The wage gap between public institutions and private businesses

college graduates and beyond at a lower rate than private businesses, nonetheless hire almost double the ratio of college graduates and beyond than do private businesses. In other words, college graduates and beyond prefer to work at public institutions rather than at private businesses despite the relatively greater reward the latter provides. This warrants another analysis to investigate why the well-educated prefer to work in the relatively low-paying sector. As for seniority, the rate of return accounts for 87 percent of the wage gap. This is most likely due to the rigidly seniority-based structure of pay increases at public institutions rather than the fact that public institutions value firm-specific human capital far more than general human capital. However, we need another in-depth analysis in this regard, one that distinguishes between seniority-based rewards for firm-specific human capital and seniority-based rewards reflecting the pay structure itself. This, in turn, requires more information on the pay structure at public institutions than is currently available from the KLIPS data. Finally, the rate of return plays an overwhelmingly greater role in determining the wage gap dependent on the length of stay in the labor market. This is because, while there are more employees that have spent longer in the labor market at public institutions than there are at private businesses, public institutions provide little reward for the length of stay in the labor market.

V

Job Security at Public Institutions

The central subject of this section is the job security gap between public institutions and private businesses, and the main indicator of job security used in the analysis herein is seniority. As the summary statistics show, public institution employees, on average, possess about 1.7 times the amount of seniority than their private business counterparts. However, we need to analyze and determine whether this relatively greater seniority reflects characteristics inherent to public institutions or the relatively greater human capital that public institution employees possess. Therefore, in this section, a method known as the "survival analysis" is used.

The Cox proportional hazards model is used to measure the probabilities of employees' quitting or moving between jobs so as to measure and compare the levels of job security at public institutions and private businesses (Cox, 1972). This model measures not the probability of survival, but the probability of risk. If the resulting coefficient is positive, it indicates a high probability of risk and a low probability of survival, and therefore, a diminishing seniority. A negative coefficient, on the other hand, indicates an increasing seniority. Therefore, the lower the coefficient (i.e., negative), the greater job security a given workplace provides. At this point, we should take caution and remind ourselves that these coefficients resulting from the Cox model do not directly reflect the risk rate. Given the structure of the risk rate function in this model, the actual risk rate would be expressed as $\exp(X_k\beta_k)$.

The analysis of the survival function involves the use of a public institution dummy variable in order to estimate the difference between public

institutions and private businesses in terms of the risk rate. The individual employee idiosyncrasies considered include sex, educational attainments, and the length of stay in the labor market, extending from the date on which individuals started working at their current workplaces. The total unemployment rates at the times when individuals started and quit working at their current workplaces are also taken into account. According to the theory of the matching model, which is commonly used in labor market analyses, we need to first derive a measure of joint productivity, called the match quality, from the productivity distribution curve. Only employees and employers whose match quality exceeds a certain threshold of this productivity can match one another, enter an employment contract, and start production together. Bowlus (1995) argues that this match quality changes in response to business cycle fluctuations. During an economic slowdown, the chances of mismatch increase and the match quality declines, thus increasing the likelihood of employment contracts reaching termination. As business cycle fluctuations affect the productivity of the match between employees and employers, employees of similar characteristics and qualifications may stay at their given jobs longer or shorter depending on when they started working at those jobs. In order to control the changes in job security resulting from these business cycle fluctuations, it was necessary to consider the total unemployment rates at both the times employees started working at and left their workplaces. In the earlier wage equation models and the simple regression analysis of seniority, total unemployment rates were controlled for the same purpose.

The survival function estimates listed in <Table V-3> imply the following. First, women are at greater risk of losing their current jobs than are men. While the risk of losing one's job decreases with one's educational attainments, this study reveals that the risk is lowest among employees with less than high school education and the highest among employees with vocational college diplomas. The risk for college graduates and beyond appears to be lower than that for high school graduates, but this is because industry/occupation type and workplace size have not yet been controlled. Once the workplace size is controlled, the statistical significance of the difference between college and high school graduates disappears. The reason for this is that job security is generally

〈Table V-1〉 **Seniority Survival Analysis**

	(1)	(2)	(3)	(4)	(5)
Public institutions	−0.942**	−0.914**	−0.899**	−0.773**	−0.759**
	(0.096)	(0.098)	(0.103)	(0.098)	(0.103)
Women	0.512**	0.511**	0.542**	0.510**	0.532**
	(0.036)	(0.037)	(0.041)	(0.037)	(0.041)
Less than high school	−0.106*	−0.100	−0.111*	−0.182**	−0.176**
	(0.051)	(0.052)	(0.053)	(0.052)	(0.053)
Vocational college graduate	0.056	0.087	0.078	0.109*	0.108*
	(0.047)	(0.048)	(0.049)	(0.048)	(0.050)
College graduate and beyond	−0.140**	−0.100*	−0.119*	−0.035	−0.054
	(0.046)	(0.048)	(0.053)	(0.047)	(0.053)
Length of stay in labor market since starting work at current workplace	0.062**	0.067**	0.068**	0.063**	0.064**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
U_0		11.855**	11.603**	10.536**	10.408**
		(1.101)	(1.108)	(1.117)	(1.120)
U_T		22.201**	23.100**	22.525**	23.100**
		(1.747)	(1.739)	(1.804)	(1.776)
Industry/occupation type	N	N	Y	N	Y
Workplace size	N	N	N	Y	Y
N	7106	7106	7106	7106	7106

Notes: 1) *p 〈 0.05, ** p 〈 0.01
2) Figures in parentheses indicate standard deviations

higher at large workplaces, where many college graduates also tend to work. The risk of losing one's job increases with the length of stay in the labor market, extending from the date on which one started working at one's current workplace. This is due to the fact that the length of stay in the labor market is inversely proportional to the period of time one can spend at one's current job. Furthermore, it was found that the higher the total unemployment rate at the job-starting point, the greater the risk of losing one's job. This finding confirms

the conclusion Bowlus (1995) has reached regarding the increased probability of employee-employer mismatch when the business cycle is down. Then why does the risk of losing one's job also increase when the total unemployment rate is high at the time one leaves one's current job? This can be explained by the declining productivity of the overall economy forcing out jobs with low match quality. The public institution dummy variable, unlike in the wage equation models or the simple regression analysis of log seniority, shows that the risk of losing one's job is generally low at public institutions, even when industry/occupation type and workplace size are controlled. The risk rate at public institutions when these workplace characteristics are not controlled is $0.389(=\exp(-0.942))$, which is about 60 percent lower than the risk rate at private businesses. Even when all the workplace characteristics are controlled, the risk rate at public institutions reaches $0.47(=\exp(-0.759))$, which is about 50 percent lower than the risk rate at private businesses.[20] In other words, everything else being equal, employees at public institutions enjoy far greater job security than their counterparts at private businesses. Let us now derive the survival function based on these risk estimates.

20) Recall that the following correlation arises between differing risk rates, given a basic risk rate and an individual factor, X: $\lambda(t \mid X) = \lambda_0(t)\exp(\beta' X)$

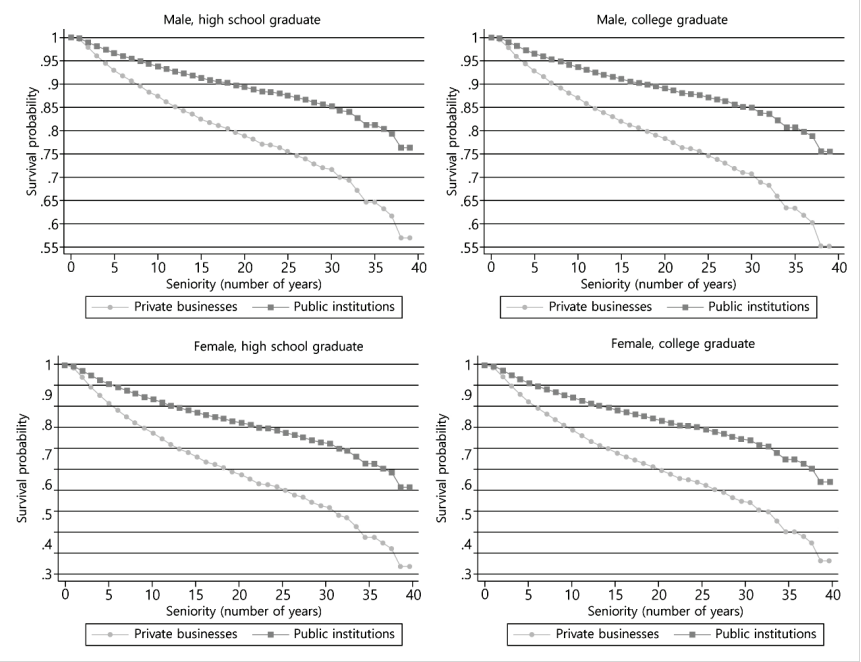
The risk rate of public institution employees can be expressed as follows:

$\lambda(t|Public\ \ Institution) = \lambda_0(t)\exp(\beta^{Public\ \ Institution})$

The basic risk rate is the risk rate for private business employees. The risk rate of public institution employees in relation to that of private business employees, therefore, can be expressed as follows:

$$\triangle(t|Public\ \ Institution)\% = \frac{\lambda_0(t) - \lambda_0(t)\exp(\beta^{Public\ \ Institution})}{\lambda_{0(t)}} = 1 - \exp(\beta^{Public\ \ Institution})$$

[Figure V-1] **Seniority-Dependent Survival Probability**



[Figure V-1] shows how employees' survival probability, depending on their levels of seniority, differ by sex and educational attainment. The first panel shows the differing levels of survival probability in male high school graduates and male college graduates, while the second panel shows the differing levels of survival probability in female high school graduates and female college graduates. Both panels also distinguish between private businesses and public employees. Irrespective of sex and educational attainment, the survival function for private businesses is far lower than that for public institutions at all points of seniority. The probability that male high school graduates will continue to work at private businesses 10 years down the road is 0.85, but decreases continually to 0.75 after 20 years, to 0.68 after 30 years, and to 0.5 after 40 years. The case for public institutions, starting at 0.88 after 10 years, decreases only slightly to 0.73 after 40 years, which is equivalent to the survival probability

of private business employees after 23 years. In other words, employees at public institutions enjoy far greater job security than their counterparts at private businesses.

<Table V-4> shows the estimated seniority expectancy for each sector on the basis of the estimated survival probabilities.[21] Before comparing public institutions and private businesses, take a look at the differing levels of seniority expectancy by sex and educational attainment. In general, men enjoy greater seniority expectancy than women. However, no such difference is observed between high school graduates and college graduates. This suggests that the coefficient for the college graduate and beyond dummy variable in the estimation of proportional risk rates lacks statistical significance. Public institutions, in general, afford three more years of expected seniority than private businesses.

This survival analysis and seniority and job security estimates reveal that public institutions offer their employees far greater survival probability than do private businesses, which translates into greater seniority expectancy for public institution employees than for private business employees.

〈Table V-2〉 **Seniority Expectancy Based on Survival Analysis: By Educational Attainment and Sex**

Unit: number of years

	High school graduate		College graduate	
	Private businesses	Public institutions	Private businesses	Public institutions
Men	33.4	36.5	33.3	36.4
Women	29.5	34.2	29.3	34.0

21) We can use the survival function to estimate the seniority expectancy for employees of different sexes, educational attainments, and sectors:

$$\mu(Male,\ high\,school\,graduate,\ \mathrm{sector}) = \int_{t=0}^{\infty} S(t \mid Male,\ high\,school\,graduate,\ \mathrm{sector})dt$$

VI

Wage Stability at Public Institutions

The topic of this section is wage stability at public institutions. In order to understand why we need to consider and analyze wage stability before proceeding to the empirical analysis of the supposed public-private wage gap, we will use the example of a hypothetical economy. After discussing the method used to measure the wage stability of each sector on the basis of the wage equation estimates, we will discuss the empirical analysis findings in depth.

1 Why do we need to analyze wage stability?

In economics, individual economic actors are generally treated as risk-averse. When given limited access to the financial market, risk-averse workers become motivated to accumulate precautionary savings. To this end, they increase either the amount of their personal savings or their working hours so as to minimize the risk of wage instability. When forced to choose between two workplaces offering equal amounts of average income, but one with greater wage stability and the other with less, the risk-averse worker will choose the former. Therefore, workplaces with unstable wage systems are compelled to pay higher wages—as risk premiums—than workplaces with more stable wage systems so as to attract and recruit risk-averse workers. Considering these risk premiums, the wage level at workplaces with relatively higher wage stability will, therefore, be lower than the wage level at relatively unstable workplaces. If two workplaces, with differing levels of wage stability, offer the same wage level, we may assume that the wages paid by the one with greater instability

include such risk premiums. This is why we need empirical analyses of wage stability to determine the real wage levels of different workplaces in light of the different levels of wage stability. Consider the following hypothetical example.

Let us suppose a model economy in which individuals live out four given terms. In this hypothetical economy, workplaces pay wages according to either of the following two wage systems:

$$\omega_1 = \{2,2,2,2\}$$
$$\omega_2 = \{1,3,1,3\}$$

The average amount of income offered by both types of workplaces is the same, at four (4). However, workplaces of the first type entail zero risk of change in wages, while those of the second type entail a risk dispersion value of 1.33. Let us suppose that all the economic actors in this economy, living for only four terms, possess risk-averse utility functions and a time discount rate of one (1). If these economic actors have the option of equalizing their spending patterns irrespective of their income levels, they will have the same amount of utility irrespective of which type of workplace they choose. The two wage systems thus become indistinct, and workplaces of both types can exist alongside one another in this economy. However, if this economy offers no means of accumulating savings, economic actors will be forced to consume all the income they earn each term. Therefore, the level of utility they enjoy will vary from term to term. The total utility of the four terms can be expressed as follows:

$$U^1 = \sum_{t=1}^{4} u(w_1) = \sum_{t=1}^{4} \log(w_1) = (\log(2)+\log(2)+\log(2)+\log(2)) \approx 2.77$$
$$U^2 = \sum_{t=1}^{4} u(w_2) = \sum_{t=1}^{4} \log(w_2) = (\log(1)+\log(3)+\log(1)+\log(3)) \approx 2.20$$

An individual in this hypothetical economy will end up earning eight (8) in total income over four terms no matter which workplace he or she chooses. However, workplaces of the first type offer greater total utility than those of the second type. At equilibrium, economic actors will therefore choose

workplaces of the first type because of the greater wage stability they offer. Workplaces of the second type will eventually disappear unless they provide risk premiums on top of their usual wages. Let the risk premium equal γ, which can be expressed as follows:[22)]

$$\begin{aligned} & U(w_1) = U(w_2+\gamma) \\ & \Rightarrow 4\times\log(2) = 2\times[\log(1+\gamma)+\log(3+\gamma)] \\ & \Rightarrow \gamma = \frac{-4\pm\sqrt{4^2+4}}{2} = \frac{-4\pm\sqrt{20}}{2} \end{aligned}$$

Where $\gamma > 0 (\gamma < 0,$ spending turns negative and utility increases infinitely in that direction. Therefore, $\gamma \approx 0.236$. Therefore, workplaces of the second type have to pay a risk premium of at least 0.236 in order to make economic actors choose them with a probability equal to which they choose the first type. The resulting total income from the second-type workplaces for each individual will amount to $(\omega_2+4\gamma) = 8.944$, about one higher than the total income from the first-type workplaces. Holding wage stability at public institutions higher and everything else equal, the wage level at public institutions should be lower than that at private businesses. That is why we need to analyze wage stability as part of our wage gap analysis.

2 Method for estimating wage stability

The following equation can be used to estimate wage stability.

$$\ln\omega_{i,j,t} = X_{i,t}\beta + \theta_i + \psi_i + \upsilon_{i.j.t}$$

$w_{i,j,t}$ is the amount of wage that an individual, i, receives from his or her workplace, either a public institution or a private business ($j \in \{Public\ Institution,\ Private\ Business\}$), at time i. $X_{i,t}$ is the vector of the individual's idiosyncrasies, including his or her sex, educational attainments,

22) See the Appendix for the specifics of the risk premium estimation process

length of stay in the labor market and its square, and seniority and its square. θ_1 represents the individual fixed effect, i.e., the effect of unobserved idiosyncrasies of the individual, while ψ_1 stands for the sector-specific fixed effect. $\mu_{i,j,t}$ represents the probable wage the individual receives at each point in time, consisting of the individual-specific idiosyncratic shock and the sector-specific idiosyncratic shock, which reflects the structural characteristics of the given sector independent of the individual's productivity. More specifically, $\mu_{i,j,t}$ can be expressed as follows:

$$\mu_{i,j,t} = k_{j,t} + n_{i,t}$$

Here, $k_{j,t}$ represents the sector-specific idiosyncratic shock, and $\eta_{i,t}$ the individual-specific idiosyncratic shock. We assume that the two shocks are independent of each other, i.e., $k_{j,t} + n_{i,t}$. Assuming that all individual-specific idiosyncratic shocks are distributed according to the same pattern, σ_η^2 will be identical for all individuals. Using this, we may estimate the cross-sectional dispersion of wages in each sector as follows:

$$\sigma^2_{Private\ Business} = var(\kappa_{Private\ Business,t} + \eta_{i,t}) = var(\kappa_{Private\ Business,t}) + var(\eta_{i,t}) = \sigma^2_{\kappa_{Private\ Business}} + \sigma^2_\eta$$

$$\sigma^2_{Public\ Institution} = var(\kappa_{Public\ Institution,t} + \eta_{i,t}) = var(\kappa_{Public\ Institution,t}) + var(\eta_{i,t}) = \sigma^2_{\kappa_{Public\ Institution}} + \sigma^2_\eta$$

The cross-sectional wage dispersion of each sector is expressed as the sum of the given sector's specific idiosyncratic shock and individual-specific idiosyncratic shock. The difference between the two sectors' dispersions, therefore, reflects the difference in the dispersion of shocks in each sector.

Next are the formulae for estimating the wage stability premium of public institutions. Returning to the residuals of the wage equations we have seen earlier, they are distributed as follows:

$$\kappa_{j,t} \sim N\left(0, \sigma^2_{\kappa_j}\right)$$
$$\eta_{i,t} \sim N\left(0, \sigma^2_\eta\right)$$
$$u_{j,i,t} = \kappa_{j,t} + \eta_{i,t} \sim N\left(0, \sigma^2_j \left(= \sigma^2_{\kappa_j} + \sigma^2_\eta\right)\right)$$

Recall that the wage used in the wage equations was a log wage. Then, the wage residual, $W_{i,t} \mid j$, in a given sector, will be dispersed as follows:[23)]

$$\widetilde{W}_{i,t} \mid j = \exp\left(-\frac{\sigma_j^2}{2}\right)\exp(u_{i,t}) \mid j \sim N\left(0, \left(\exp(\sigma_j^2)-1\right)\exp(\sigma_j^2)\right)$$

Then, we need to estimate the additional wage private businesses should pay or public institutions should cut in order to eliminate the difference in employee welfare resulting from the difference in wage stability between public institutions and private businesses.[24)]

$$E\left(u\left(\widetilde{W}_{i,t}\right) \mid \mathrm{Private\ Business}\right) = E\left(u\left((1+\triangle)\widetilde{W}_{i,t}\right) \mid \mathrm{Public\ Institution}\right)$$

Here, the wage level in each sector will be distributed as follows:

$$\widetilde{W}_{i,t} \mid \mathrm{Private\ Business} \sim N\left(0, \left(\exp(\sigma^2_{\mathrm{Private\ Business}})-1\right)\exp(\sigma^2_{\mathrm{Private\ Business}})\right)$$

$$\widetilde{W}_{i,t} \mid \mathrm{Public\ Institution} \sim N\left(0, \left(\exp(\sigma^2_{\mathrm{Public\ Institution}})-1\right)\exp(\sigma^2_{\mathrm{Public\ Institution}})\right)$$

Using the Constant Relative Risk Aversion (CRRA) utility function with γ as the risk aversion coefficient, we can estimate $\triangle$ as follows: [25)]

$$\triangle = \frac{1}{2}\left(\sigma^2_{\mathrm{Public\ Institution}} - \sigma^2_{\mathrm{Private\ Business}}\right)\gamma$$

23) To compensate for the dispersion-dependent changes in averages in a log normal distribution, we consider $\exp(-\sigma_j^2/2)$

24) As for the risk premium, we use the method introduced in the "Analysis of Fringe Benefits under Public Policies" by Lucas (2003). The method involves removing the influence of spending fluctuations from fringe benefit levels using the information on fringe benefit and business cycle readjustment policies. The goal is to measure and identify fringe benefit levels in two situations, one with spending fluctuations left intact and the other with them removed, so as to determine how much the fringe benefit level in the former should be raised in order to make the two levels identical

25) See the Appendix for the induction process

This equation implies that the public-private difference in wage stability, as shown in different dispersions, should be adjusted first in order to bring the employee's expected utility levels in the two sectors to an equal level. In other words, if the wage stability at private businesses is lower than that at public institutions (i.e., if the dispersion at private institutions is greater than that at public institutions), either public institutions need to cut their wage level or private businesses need to raise theirs in order to make the expected utility levels in the two sectors equal. Influencing the size of the wage level to be adjusted, in light of the difference in wage stability, is the risk aversion coefficient. The greater the risk aversion, the lower the utility of wage instability. Henceforth, the sector with the higher wage instability should pay higher wages. Therefore, wage premiums can be defined as the margin by which the less stable sector's wage level is higher than that of the more stable sector.

3 Analyzing wage stability at public institutions

The majority of wages at private businesses is determined according to market mechanisms. At public institutions, however, wages are more subject to the government's control over the total labor cost ceiling, as well as to how institutions rate on governmental evaluations of management performance. Therefore, the wage system at public institutions remains much more stable than the wage system at private businesses, unless abrupt changes occur in the government budgets or policies. We thus need to determine whether and how this difference in wage stability is reflected in the wage gap.

The first subsection of this section provides a detailed description of the method used to estimate the respective wage stability of private businesses and public institutions. First, we develop a wage equation and identify the residuals. Then, we measure the dispersion of the residuals in each sector (i.e., $\hat{\sigma}^2_{Private\ Business}$ and $\hat{\sigma}^2_{Public\ Institution}$). By placing these in the following equation, we can estimate the risk/wage premium the less stable sector should pay.

$$\triangle = \frac{1}{2}\left(\sigma^2_{Public\ Institution} - \sigma^2_{Private\ Business}\right)\gamma$$

See the following table for the estimated wage premiums obtained from the equation above:

The by-sector dispersions are 0.133 for private businesses and 0.111 for public institutions, indicating that wages are more unstable at the former than at the latter. In order to attract and recruit risk-averse workers of similar qualifications from the public sector, private businesses will need to pay a concomitant amount of risk premiums. The required amount of risk premiums changes according to the strength of risk aversion. If the risk aversion coefficient is one (1), with individual economic actors possessing log utility functions, private businesses need to pay at least 1.1 percent more in wages than public institutions in order to provide individuals with an equal level of expected utility.

〈Table VI-1〉 **Wage Stability of Each Sector**

	Private businesses	Public institutions	Total
Standard deviation	0.365	0.333	0.363
Dispersion	0.133	0.111	0.132
Ratio (%)	93.5	6.5	100
△(%)		$(-1.1)\times\gamma$	

If the risk aversion coefficient is two (2), the value most frequently used in macroeconomic literature, private businesses will need to pay at least 2.2 percent more in wages. If private businesses and public institutions offer equal wage levels, we can infer that it is public institutions and not private businesses that are paying wage premiums.

VII

Comparison of Expected Wage Levels

In this last section, we finally proceed onto the expected wage gap between private businesses and public institutions, on the basis of the wage equation estimates, the seniority-dependent survival probability estimates, and the wage stability estimates we obtained and analyzed in the earlier sections. First, assuming that the survival probability is equal for public institutions and private businesses, we compare the possible wage levels of the two sectors without considering the difference in wage stability. Next, we compare two different expected wage levels based on an equal survival probability and different levels of wage stability, and then estimate the seniority-dependent expected wage level for each sector based on the survival probability estimates we obtained from our earlier survival analysis. Finally, we bring all of these estimates together and discuss the factors that must be considered in policymaking when determining seniority-dependent expected wage levels for public institutions and private businesses.

1 Wage levels reflecting the difference in wage stability

The core assumption underlying the wage equation model used in Section IV is that the current level of seniority among the employees of each sector will remain the same in the future, without analyzing and estimating the probability of increasing seniority at each given workplace. Therefore, these estimates reflect no survival probabilities. Moreover, the model also presupposes

that the level of wage stability remains equal at public institutions and private businesses alike. In this section, however, we modify our expected wage level estimates by taking both factors into account. First, we need to analyze how the wage level changes in response to increases in seniority. Next, we need to determine how the difference in wage stability will affect the wage level of each sector.

Seniority-dependent wage levels are estimated on the basis of the single wage equation model, which controls all individual and workplace idiosyncrasies as well as the total unemployment rates. The seniority-dependent wage level of male employees with high school education can be expressed as follows:

$$\widehat{W}(t \mid Male,\ high\ school\ graduate,\ Private\ Business) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2\right)$$
$$\widehat{W}(t \mid Male,\ high\ school\ graduate,\ Public\ Institution) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + \hat{\beta}^{Public\ Institution}\right)$$

The same for male employees with college education and beyond is estimated by adding a college education dummy variable to the equations above, while the same for female employees is estimated by adding a female dummy variable. For instance, the wage level of female employees with college education and beyond can be expressed as follows:

$$\widehat{W}(t \mid female, college\,education, Private\ \ Business) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + \hat{\beta}_{female} + \hat{\beta}_{college\,education}\right)$$

$$\widehat{W}(t \mid female, college\,education, Public\ \ Institution) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + \hat{\beta}_{female} + \hat{\beta}_{college\,education} + \hat{\beta}^{PublicInstitution}\right)$$

Here, each wage level indicates the wage level an employee in each sector can expect to receive by working at the same workplace until time t. He or she will not receive this wage if he or she retires before time t.

Earlier, we used a wage equation model to estimate the seniority-dependent wage levels. Now, we need to find a wage level for public institutions that reflects and compensates for the difference in wage stability between public institutions and private businesses. In order to equalize the expected utility for employees of public institutions and private businesses despite the difference

in wage stability, public institutions need to cut their wage level as follows:

$$\triangle = \frac{1}{2}\left(\sigma^2_{Public\ Institution} - \sigma^2_{Private\ Business}\right)\gamma$$

Here, γ stands for the risk aversion coefficient used in individual employees' utility function. Taking the difference in wage stability into account, we can estimate the seniority-dependent wage level for male employees with high school education as follows:

$$\widetilde{W}(t \mid male, high\,school\,graduate, Private\,Business) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2\right)$$
$$\widetilde{W}(t \mid male, high\,school\,graduate, Public\,Institution) = \exp\left(\hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2 + \hat{\beta}^{Public\,Institution}\right)$$
$$\left(1 + \frac{1}{2}\left(\sigma^2_{Public\,Institution} - \sigma^2_{Private\,Business}\right)\right)$$

We can estimate the final seniority-dependent expected wage level for each sector by multiplying the seniority-dependent wage level, obtained above, by the survival probability of each level of seniority.

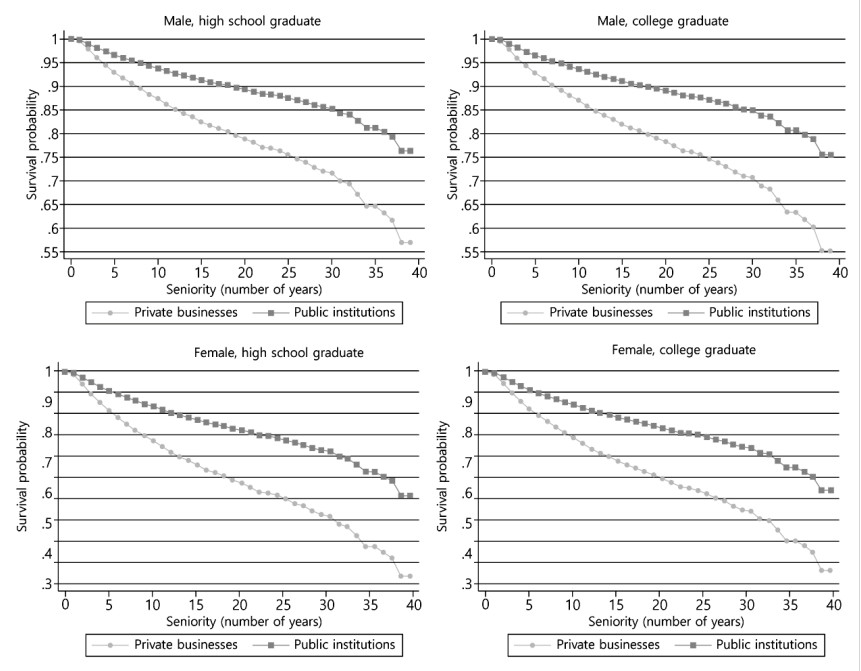
$$EW(t \mid male, high\,school\,graduate, Private\,Business) =$$
$$\hat{S}(t \mid male, high\,school\,graduate, Private\,Business)\,\widetilde{W}(t \mid male, high\,school\,graduate, Private\,Business)$$

$$EW(t \mid male, high\,school\,graduates, Public\,Institution) =$$
$$\hat{S}(t \mid male, high\,school\,graduate, Public\,Institution)\,\widetilde{W}(t \mid male, high\,school\,graduate, Public\,Institution)$$

2 Seniority-dependent expected wage levels

First, let us compare the seniority-dependent expected wage levels at public institutions and private businesses, assuming an equal level of survival probability for both and that employees work at the same workplaces until time t. [Figure VII-1] shows the changing seniority-dependent wage levels based on the wage equation estimates.

[Figure VII-1] **Seniority-Dependent Wage Levels**

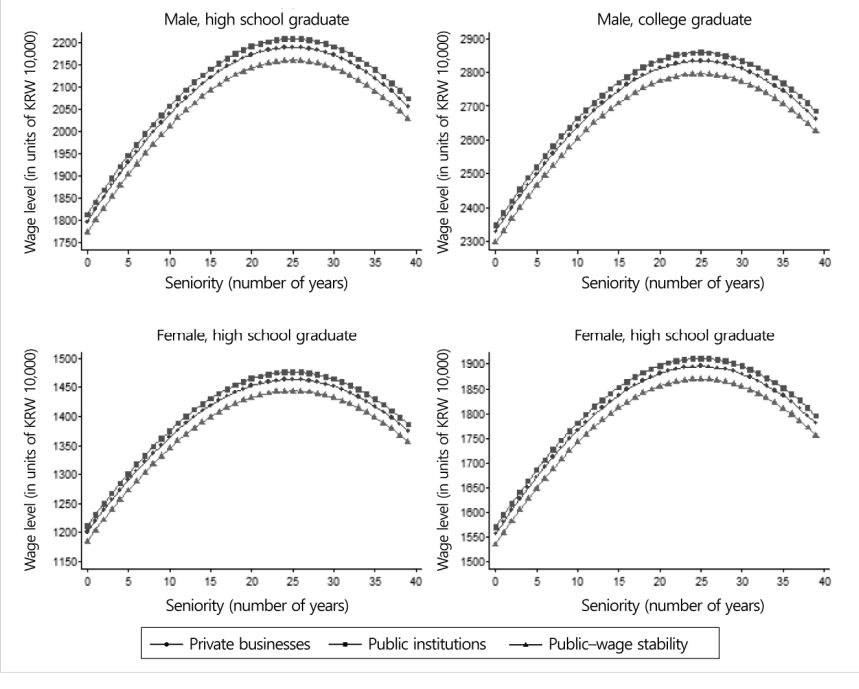


All curves follow an inverse-U trajectory, reaching their peaks at or around year 25 before beginning to decline. In general, the higher the educational attainment, the higher the wage level. Also, men receive higher wages than women. The two upper graphs show the seniority-dependent expected wage levels of the two sectors without taking into account the difference in wage stability between the two sectors. The wage gap in this case is estimated on the basis of the public institution dummy variable. As the log wage regression analysis shows (<Table IV-1>), the public institution dummy loses its statistical significance when we control industry/occupation type and workplace size. Hence, the wage gap almost vanishes. The bottom curve indicates the wage level public institutions should meet in order to make the expected employee utility in both sectors equal, in light of the difference in wage stability and given a risk aversion coefficient of two (2). Given the higher wage stability

at public institutions, the expected utility becomes equal for employees, in whichever sector they work, even if public institutions offer lower wages. If the wage level at public institutions is determined without considering the wage stability difference, public institutions end up paying wage premiums by paying wages similar to those paid by private businesses. The amount of public institution wage premiums is then expressed as the difference between the private business wage level and the public institution wage level reflecting the greater wage stability.

Now, let us examine how considering survival probabilities changes the seniority-dependent expected wage levels. [Figure VII-2] shows seniority-dependent wage levels, multiplied by seniority-dependent survival probabilities, by sex, educational attainment, and sector.

[Figure VII-2] **Seniority-Dependent Wage Levels**



The expected wage levels for private business employees now display continuous declines instead of inverse-U shapes. In particular, the seniority-dependent expected wage levels for women of all educational backgrounds decline rapidly. On the other hand, the expected wage levels for male employees at public institutions continue to grow slowly toward the peak, at around 20 years of seniority, before beginning to decline. The wage levels for female employees at public institutions also continuously decline, as they do at private businesses, but at a slower pace. The different paces at which the wage levels decline reflect the different paces at which survival probabilities decrease at different points in seniority. At private businesses, survival probabilities decrease abruptly as seniority increases, at a much faster pace than that of the wage level increase. That is why the expected wage levels for private businesses continue declining. On the other hand, the pace of decline in survival probabilities is slower for male employees at public institutions, which is why their wage level continues to increase until reaching a peak at about 20 years into their seniority. At this point, the gap between public institutions and private businesses in terms of expected wage levels becomes manifest. When we assumed an average seniority of 40 years for employees of both sectors, the gap was not so apparent. However, when we take into account the difference in survival probabilities, it can be seen that public institutions pay about KRW 5 million won more for each employee on average, everything else being equal. In other words, the difference in survival probability, i.e., job security, widens the gap in expected wage levels. Wage stability also serves to reveal the gap in expected wage levels.

<Tables VII-1> and <VII-2> list the results of more detailed quantitative analyses of the changes that occur every five years in the expected wage levels for male and female employees of the two sectors. The initial-year wage levels do not differ significantly by sector. Employees at public institutions each receive about KRW 150,000 more than their counterparts at private businesses. With increases in seniority, however, the expected wage gap between the two sectors widens, reaching the biggest difference at KRW 4.9 million per employee at 40 years of seniority. After 20 years of seniority, the expected wage levels begin to decline in both sectors. However, the rate of decline is much faster at private businesses than at public institutions, which is why the expected wage gap

between the two sectors continues to widen even after 20 years of seniority. This phenomenon occurs irrespective of the differences in employees' sexes and educational attainments.

〈Table VII-1〉 **Seniority-Dependent Expected Wages for Male Employees**

Seniority (number of years)	High school graduates			College graduates		
	Private businesses	Public institutions		Private businesses	Public institutions	
		Stability not controlled	Stability controlled		Stability not controlled	Stability controlled
1	1797.1	1812.6	1772.7	2327.1	2347.2	2295.6
	(100.0)	(100.9)	(98.6)	(100.0)	(100.9)	(98.6)
5	1787.3	1864.8	1823.8	2322.1	2418.6	2365.4
	(100.0)	(104.3)	(102.0)	(100.0)	(104.2)	(101.9)
10	1756.7	1908.2	1866.3	2291.5	2479.5	2425.0
	(100.0)	(108.6)	(106.2)	(100.0)	(108.2)	(105.8)
15	1720.3	1933.0	1890.4	2251.6	2515.6	2460.2
	(100.0)	(112.4)	(109.9)	(100.0)	(111.7)	(109.3)
20	1672.5	1935.0	1892.4	2195.3	2521.6	2466.1
	(100.0)	(115.7)	(113.1)	(100.0)	(114.9)	(112.3)
25	1612.3	1913.1	1871.0	2121.6	2496.0	2441.1
	(100.0)	(118.7)	(116.0)	(100.0)	(117.6)	(115.1)
30	1497.7	1843.3	1802.7	1977.8	2408.9	2355.9
	(100.0)	(123.1)	(120.4)	(100.0)	(121.8)	(119.1)
35	1292.5	1701.5	1664.0	1718.3	2230.5	2181.5
	(100.0)	(131.6)	(128.7)	(100.0)	(129.8)	(127.0)
40	1068.4	1526.3	1492.7	1431.9	2008.4	1964.3
	(100.0)	(142.9)	(139.7)	(100.0)	(140.3)	(137.2)

Notes: 1) Unit: KRW 10,000
2) Figures in parentheses represent ratios in comparison to private businesses

〈Table VII-2〉 **Seniority-Dependent Expected Wages for Female Employees**

Seniority (number of years)	High school graduates			College graduates		
	Private businesses	Public institutions		Private businesses	Private businesses	
		Stability not controlled	Stability controlled		Stability not controlled	Stability controlled
1	1201.7	1212.1	1185.4	1556.1	1569.5	1535.0
	(100.0)	(100.9)	(98.6)	(100.0)	(100.9)	(98.6)
5	1142.8	1221.1	1194.2	1488.3	1585.4	1550.5
	(100.0)	(106.9)	(104.5)	(100.0)	(106.5)	(104.2)
10	1065.0	1218.8	1191.9	1396.4	1587.4	1552.5
	(100.0)	(114.4)	(111.9)	(100.0)	(113.7)	(111.2)
15	997.4	1209.0	1182.4	1315.2	1578.9	1544.2
	(100.0)	(121.2)	(118.5)	(100.0)	(120.1)	(117.4)
20	932.9	1188.6	1162.4	1236.3	1555.8	1521.6
	(100.0)	(127.4)	(124.6)	(100.0)	(125.8)	(123.1)
25	869.8	1156.9	1131.4	1157.5	1517.4	1484.0
	(100.0)	(133.0)	(130.1)	(100.0)	(131.1)	(128.2)
30	769.8	1089.7	1065.7	1030.7	1433.4	1401.8
	(100.0)	(141.6)	(138.4)	(100.0)	(139.1)	(136.0)
35	607.9	964.9	943.7	823.2	1275.9	1247.8
	(100.0)	(158.7)	(155.2)	(100.0)	(155.0)	(151.6)
40	451.0	822.9	804.7	619.2	1095.1	1071.0
	(100.0)	(182.4)	(178.4)	(100.0)	(176.9)	(173.0)

Notes: 1) Unit: KRW 10,000
2) Figures in parentheses represent ratios in comparison to private businesses

When workplace idiosyncrasies are controlled, there is almost no wage gap between the two sectors among employees of equal seniority. When the difference in wage stability is taken into account, however, we can see that the absence of the wage gap in fact indicates that public institutions pay wage premiums. The amount of these premiums, however, is two percent or so when the risk aversion coefficient is two (2). On the other hand, taking into account the difference in survival probabilities reveals a widening and manifest wage gap, particularly as seniority increases. This gap reflects the difference between the two sectors in terms of seniority-dependent survival probabilities, i.e., job security.

VII

Conclusion

Based on the KLIPS work histories and data gathered over a 13-year period, this study empirically analyzes and demonstrates the supposed wage gap between public institutions and private businesses and the possible causes thereof.

First, in order to determine whether such a wage gap really exists, this study employs a single wage equation model, which holds the log wages of individual employees as dependent variables, controls the individual and workplace idiosyncrasies as independent variables, and uses a public institution dummy variable in order to determine whether public institutions do offer wage premiums. To this, a fixed-effects analysis was added in order to control the unobserved heterogeneity among individual employees. Furthermore, assuming the difference in the rates of return between public institutions and private businesses, this study employed separate wage equations for the two sectors in order to identify and decompose the wage differences resulting from different rates of return and sector-specific factors or idiosyncrasies. The empirical analysis reveals that approximately 85 percent of the wage gap between public institutions and private businesses is due to individual idiosyncratic differences. When even unobserved heterogeneity is controlled using a fixed-effects analysis, however, the statistical significance of the wage gap disappears. The decomposition of factors based on sector-specific wage equations and the resulting estimates reveal that the seniority and educational attainments of individual employees are the two major factors accounting for the apparent wage gap between the two sectors. More specifically, seniority creates such a gap even under different rates of return and with sector differences. Educational attainments, however, create such

a gap precisely by virtue of sector differences, even when the rate of return is held equal for both sectors.

These results indicate that people in possession of greater human capital prefer to work at public institutions in Korea. At first sight, this pattern appears quite curious, as public institutions in Korea do not seem to offer any wage premiums. In order to find the cause, this study then provides empirical analyses of job security and wage stability at public institutions and private businesses. Job security was estimated using a survival analysis involving seniority, while wage stability was estimated by obtaining the dispersion of residuals from the single wage equation estimates for each sector. The survival probabilities, estimated after the survival functions were identified, reveal that public institution employees enjoy far greater survival probabilities than their private business counterparts, even after individual and workplace idiosyncrasies are controlled. For instance, a male employee of a public institution with high school education is 1.2 times and 1.6 times more likely than his private business counterpart to retain his job at the same workplace 25 years and 40 years into his career, respectively. He also enjoys 20 percent more wage stability than his counterpart. Therefore, in order to attract and recruit risk-averse workers from the public sector by offering an equal level of expected utility, a private business should pay at least two percent more in wages, assuming a risk aversion coefficient of two (2). In reality, however, public institutions pay about two percent more as wage premiums than private businesses in the form of greater wage stability. This is why risk-averse workers prefer to work at public institutions than at private businesses.

Considering all of these factors, we can infer that job security and wage stability are the two main reasons people prefer to work at public institutions rather than at private businesses in Korea. Taking these estimates into account, this study estimates the expected wage levels for the two sectors according to different amounts of seniority. In their first year of work, employees see little difference in expected wages, regardless of whether they work at public institutions or at private businesses, as their wage levels and survival probabilities are almost equal. Considering the greater wage stability of public institutions, the expected wage level at public institutions should be lower than that at private businesses. However, the actual levels are almost equal, indicating that public

institutions pay about two percent more as wage premiums even for first-year employees. As seniority increases, the expected wage levels decrease in both sectors as employees' survival probabilities decrease. However, the two sectors differ significantly in terms of the rate of decline, with the wage gap widening as seniority increases accordingly. As a result, male and female employees at public institutions earn about 40 percent and 75 percent more than their private business counterparts, respectively, 40 years into their work. This is strong enough an incentive to lure employees with high human capital to work at public institutions rather than at private businesses.

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Appendix

1 Number of sample households in the KLIPSs

〈Appendix Table 1〉 **Number of Sample Households in the KLIPSs**

Year	Total	Newly added
1998	13,321	–
1999	12,037	–
2000	11,205	466
2001	11,051	240
2002	10,966	402
2003	11,541	558
2004	11,661	444
2005	11,580	381
2006	11,756	398
2007	11,855	396
2008	11,734	392
2009	14,489	3,110
2010	14,118	490
Total	21,609	7,277

2 Industry and occupation classifications

A. Industry classification

〈Appendix Table 2〉 **Industry Classification**

	Serial no.	Sector	Code	Industries included
1	1	Agriculture and forestry	1	Agriculture
			2	Forestry
	2	Fishery	5	Fishery
	3	Mining	10	Coals, crude oil, and uranium
			11	Metals
			12	Non-metallic ore (not including fuels)
2	4	Manufacturing	See attachment.	
3	5	Power, gas, and water supplies	40	Power, gas, and other national industries
			41	Waterworks
	6	Construction	45	General construction
			46	Specialized construction
4	7	Wholesale and retail	50	Automobile sales and automobile fuel retail
			51	Wholesale and product intermediation
			52	Retail (excluding automobiles)
	8	Lodging and restaurants	55	Lodging and restaurants
	9	Transportation	60	On-land and pipeline transportation
			61	On-water transportation
			62	Transportation by air
			63	Tourism agency, warehouse, and transportation services
5	10	Communications	64	Communications
6	11	Finance and insurance	65	Finance
			66	Insurance and pensions
			67	Financial and insurance services
	12	Real estate and rental	70	Real estate
			71	Rental of machinery and other products

〈Appendix Table 2〉 **Continued**

	Serial no.	Sector	Code	Industries included
7	13	Business services	72	Information-processing and other computer-operating services
			73	Research and development
			74	Specialized science and technology services
			75	Business support services
8	14	Public administration, national defense, and social services	76	Public administration, national defense, and social services
9	15	Education services	80	Education services
	16	Healthcare and charity work	85	Healthcare
			86	Charity work
10	17	Entertainment, culture, and sports services	87	Film, broadcasting, and performance industries
			88	Other entertainment, culture, and sports industries
11	18	Other public, repair, and individual services	90	Sewage, waste-processing, and cleansing services
			91	Voluntary associations
			92	Repair services
			93	Other services
	19	Domestic help	95	Domestic help
12	20	International organizations and foreign institutions	99	International organizations and foreign institutions

〈Appendix Table 2-1〉 **Industry Classification: Manufacturing**

Block	Serial no.	Sector	Code	Industries included
2	4	Manufacturing	15	Food and beverage
			16	Tobacco
			17	Textiles and fibers (not including apparel)
			18	Sewn apparel and furs
			19	Leather goods, bags, and shoes
			20	Lumber and wooden products (excluding furniture)
			21	Pulp and paper
			22	Publishing and media duplication
			23	Cokes, refined petroleum products, and nuclear fuel
			24	Synthetic and chemical goods
			25	Rubber and plastic goods
			26	Non–metallic mineral goods
			27	Primary metal industry
			28	Assembled metal goods (excluding machinery and furniture)
			29	Machinery and equipment
			30	Computers and office equipment
			31	Other electric and electricity–converting equipment
			32	Electronic parts and video, acoustic, and communications equipment
			33	Medicine, precision, optical devices, and watches
			34	Automobiles and trailers
			35	Other transportation equipment
			36	Furniture and other products
			37	Processed raw materials for recycling

B. Occupation classification

〈Appendix Table 3〉 **Occupation Classification**

Type	Serial no.	Category	Code	Occupations included
W	1	Legislators, high-level executives, and managers	1	Legislators, high-level executives
			2	Administrators and executive managers
			3	Managers
W	2	Specialists	11	Science specialists
			12	Computer specialists
			13	Engineering specialists
			14	Healthcare professionals
			15	Education specialists
			16	Administration, management, and finance specialists
			17	Law, social service, and religion specialists
			18	Culture, arts, and broadcasting specialists
W	3	Technicians and semi-specialists	21	Science technicians
			22	Computer semi-specialists
			23	Engineering technicians
			24	Healthcare technicians
			25	Education semi-specialists
			26	Management and finance semi-specialists
			27	Social service and religion semi-specialists
			28	Arts, entertainment, and sports semi-specialists
			29	Other semi-specialists
P	4	Office workers	31	Office workers (general administration)
			32	Customer service agents
P	5	Service workers	41	Interpersonal service workers
			42	Cooking and food service workers
			43	Tourism and transportation service workers
			44	Security service workers
P	6	Sales workers	51	Wholesale and retail sales workers
			52	Communications sales workers
			53	Commercial models and PR workers

〈Appendix Table 3〉 **Continued**

Type	Serial no.	Category	Code	Occupations included
B	7	Agriculture and fishery skilled workers	61	Agriculture skilled workers
			62	Forestry skilled workers
			63	Fishery skilled workers
B	8	Skilled workers	71	Extraction and construction skilled workers
			72	Metal and machinery skilled workers
			73	Installation and maintenance skilled workers
			74	Precision, metal works, and handicraft skilled workers
			75	Other skilled workers
B	9	Equipment, mechanical operation, and assembly workers	81	Fixed machinery and system operators
			82	Machinery operators and skilled workers
			83	Assembly workers
			84	Drivers and skilled workers
B	10	Manual laborers	91	Manual service workers
			92	Manual workers in agriculture/forestry/fishery
			93	Manual workers in manufacturing
			94	Manual workers in mining/construction/transportation

3 Wage stability at public institutions

A. Risk premium equation (four-term economy):

$$
\begin{aligned}
&U(w_1) = U(w_2+\gamma)\\
&\Rightarrow 4\times\log(2) = 2\times[\log(1+\gamma)+\log(3+\gamma)]\\
&\Rightarrow 2\log(2) = \log((1+\gamma)(3+\gamma))\\
&\Rightarrow \log(4) = \log((1+\gamma)(3+\gamma))\\
&\Rightarrow 4 = (1+\gamma)(3+\gamma) = 3+4\gamma+\gamma^2\\
&\Rightarrow \gamma^2+4\gamma-1=0\\
&\Rightarrow \gamma = \frac{-4\pm\sqrt{4^2+4}}{2} = \frac{-4\pm\sqrt{20}}{2}
\end{aligned}
$$

B. Risk premium calculation:

$$
E\left[\frac{\left(\widetilde{W}_{i,Private\ Business,t}\right)^{1-\gamma}}{1-\gamma}\right] = E\left[\frac{\left((1+\triangle)\widetilde{W}_{i,Public\ Institution,t}\right)^{1-\gamma}}{1-\gamma}\right]
$$

$$
\begin{aligned}
\widetilde{W}_{i,Private\ Business,t} &= \exp\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)\exp\left(u_{i,Private\ Business,t}\right)\\
\widetilde{W}_{i,Public Institutiion,t} &= \exp\left(-\frac{\sigma^2_{Public Institution}}{2}\right)\exp\left(u_{i,Public Institution,t}\right)
\end{aligned}
$$

$$
\begin{aligned}
E\left[\frac{\left(\widetilde{W}_{i,Private\ Business,t}\right)^{1-\gamma}}{1-\gamma}\right] &= E\left[\frac{\left(\exp\left(-\sigma^2_{Private\ Business}/2\right)\exp\left(u_{i,Private\ Business,t}\right)\right)^{1-\gamma}}{1-\gamma}\right]\\
&= \frac{\exp\left(-\sigma^2_{Private\ Business}/2\right)^{1-\gamma}}{1-\gamma}E\left[\exp\left(u_{i,Private\ Business,t}\right)^{1-\gamma}\right]
\end{aligned}
$$

$$
\begin{aligned}
&E\left[\frac{\left((1+\triangle)\widetilde{W}_{i,Public\ Institution,t}\right)^{1-\gamma}}{1-\gamma}\right] =\\
&E\left[\frac{\left((1+\triangle)\exp\left(-\sigma^2_{Public Institution}/2\right)\exp\left(u_{i,Public Institution,t}\right)\right)^{1-\gamma}}{1-\gamma}\right]\\
&\qquad = (1+\triangle)^{1-\gamma}\frac{\exp\left(-\sigma^2_{Public Institution}/2\right)^{1-\gamma}}{1-\gamma}E\left[\exp\left(u_{i,Public Institution,t}\right)^{1-\gamma}\right]
\end{aligned}
$$

$$\frac{\exp\left(-\sigma^2_{Private\ Business}/2\right)^{1-\gamma}}{1-\gamma} E\left[\exp\left(u_{i,Private\ Business,t}\right)^{1-\gamma}\right]$$
$$= (1+\triangle)^{1-\gamma} \frac{\exp\left(-\sigma^2_{Public Institution}/2\right)^{1-\gamma}}{1-\gamma} E\left[\exp\left(u_{i,Public Institution,t}\right)^{1-\gamma}\right]$$

Offset $(1/(1-\gamma))$ against both sides, and expand using logs as follows:

$$(The\ left\ side) = (1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)\right] + \ln\left[E\left[\exp\left(u_{i,Private\ Business,t}\right)^{1-\gamma}\right]\right]$$

$$(The\ right\ side) = (1-\gamma)\ln(1+\triangle) + (1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Public Institution}}{2}\right)\right] +$$
$$\ln\left[E\left[\exp\left(u_{i,Public Institution,t}\right)^{1-\gamma}\right]\right]$$

First, $\exp\left(u_{i,j,t}\right)^{1-\gamma}$expand as follows:

$$\exp\left(u_{i,j,t}\right)^{1-\gamma} = \exp\left(\ln\left(\exp\left(u_{i,j,t}\right)^{1-\gamma}\right)\right) = \exp\left((1-\gamma)\ln\left(\exp\left(u_{i,j,t}\right)\right)\right) = \exp\left((1-\gamma)u_{i,j,t}\right)$$

With $u_{i,j,t} \sim N\left(0,\sigma_j^2\right)$, $(1-\gamma)u_{i,j,t} \sim N\left(0,(1-\gamma)^2\sigma_j^2\right)$ arises, and $\exp\left(u_{i,j,t}\right)^{1-\gamma}$ thus shows the following dispersion structure:

$$\exp\left(u_{i,j,t}\right)^{1-\gamma} \sim N\left(\exp\left(\frac{(1-\gamma)^2\sigma_j^2}{2}\right), \left(\exp\left((1-\gamma)^2\sigma_j^2\right)-1\right)\exp\left((1-\gamma)^2\sigma_j^2\right)\right)$$

Using this, expand $\ln\left[E\left[\exp\left(u_{i,j,t}\right)^{1-\gamma}\right]\right]$ as follows:

$$\ln\left[E\left[\exp\left(u_{i,j,t}\right)^{1-\gamma}\right]\right] = \ln\left[\exp\left(\frac{(1-\gamma)^2\sigma_j^2}{2}\right)\right] = \frac{(1-\gamma)^2\sigma_j^2}{2}$$

Expand both sides as follows:

$$(1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)\right] + \ln\left[E\left[\exp\left(u_{i,Private\ Business,t}\right)^{1-\gamma}\right]\right]$$
$$= (1-\gamma)\ln(1+\triangle) + (1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Public Institutiion}}{2}\right)\right] + \ln\left[E\left[\exp\left(u_{i,Public Institutiion,t}\right)^{1-\gamma}\right]\right]$$

$$(1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)\right]+\ln\left[E\left[\exp\left(u_{i,Private\ Business,t}\right)^{1-\gamma}\right]\right]$$
$$=(1-\gamma)\ln(1+\triangle)+(1-\gamma)\ln\left[\exp\left(-\frac{\sigma^2_{Public\ Institution}}{2}\right)\right]+\ln\left[E\left[\exp\left(u_{i,Public\ Institution,t}\right)^{1-\gamma}\right]\right]$$

Offset $(1-\gamma)$ against both sides as follows:

$$\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)+\frac{(1-\gamma)\sigma^2_{Private\ Business}}{2}=$$
$$\ln(1+\triangle)+\left(-\frac{\sigma^2_{Public\ Institution}}{2}\right)+\frac{(1-\gamma)\sigma^2_{Public\ Institution}}{2}$$

With $\ln(1+\triangle)\approx\triangle$, is calculated as follows:

$$\triangle=\left(-\frac{\sigma^2_{Private\ Business}}{2}\right)+\frac{(1-\gamma)\sigma^2_{Private\ Business}}{2}-\left(-\frac{\sigma^2_{Public\ Institution}}{2}\right)-\frac{(1-\gamma)\sigma^2_{Public\ Institution}}{2}$$
$$=\frac{1}{2}\left(\sigma^2_{Public\ Institution}-\sigma^2_{Private\ Business}\right)\gamma$$