Journal of Economic Theory and Econometrics, Vol. 32, No. 4, Dec. 2021, 42–64

Returns to Tenure and Labor Market Mobility in Korea*

Hyunjae Lee†

Abstract In this paper, I estimate the returns to tenure of the Korean labor market and investigate the relationship between returns to tenure and labor market mobility. I begin with the two methods introduced by Altonji and Shakotko (1987) and Topel (1991) to estimate returns to tenure in Korea and the US using panel data sets and confirm that both returns to tenure and job mobility are higher in Korea. Next, the industry- and occupation-wise returns to tenure are estimated for Korea and are found to be widely variable across different divisions. Finally, the correlation coefficients between returns to tenure and job mobility among industries and occupations are estimated and show almost zero or slightly positive correlations. These patterns contradict the conventional wisdom, which predicts a negative correlation, and suggest the possibility that returns to tenure work as an incentive device to retain workers in Korea.

Keywords Returns to Tenure, Job Mobility, Korean Labor Market

JEL Classification J31, J62

*I would like to thank Yongsung Chang for his guidance and support. I also would like to thank anonymous referees. This research was supported by the BK21 FOUR (Fostering Outstanding Universities for Research) funded by the Ministry of Education(MOE, Korea) and National Research Foundation of Korea(NRF).

†Department of Economics, Seoul National University, 1, Gwanak-ro, Gwanak-gu, Seoul, Republic of Korea, E-mail: sunnyten111@snu.ac.kr

Received July 29, 2021, Revised October 5, 2021, Accepted November 9, 2021

1. INTRODUCTION

Wage returns to job tenure and job mobility are intimately related in a labor market. Workers leaving or choosing jobs for better wages and firms offering higher wage contracts to attract or incentivize workers (Lazear, 1979; Burdett and Coles, 2003) are widely accepted concepts in labor economics. However, there has been little research conducted on the correlation between returns to tenure and labor market mobility, which would be essential to understanding the mechanism behind wage structures and labor dynamics in equilibrium.

In this paper, I investigate the relationship between returns to employer tenure and job mobility in a labor market, using panel data sets from Korea and the US. Conventional wisdom says that job-to-job mobility may decrease as returns to tenure increase. Returns to tenure are interpreted as the firm-specific component of wages that would be lost should a worker leave the firm (Topel, 1991; Deelen, 2012), making workers less mobile as the returns increase. This argument stems from the classic interpretation of wage growth during one's job tenure being the result of the accumulation of firm-specific human capital, which was first suggested by Becker (1964). Under this assumption, it is reasonable to believe that a negative correlation between returns to tenure and job mobility may appear in a labor market.

At the same time, there has been a wide variety of theories proposed——other than firm-specific human capital——to explain the positive returns to tenure that have been empirically confirmed in the US labor market (Topel, 1991; Altonji and Williams, 2005; Buckinsky *et al.*, 2010). Most such theoretical explanations focus on the role of returns to tenure as an incentive device (Lazear, 1979; Burdett and Coles, 2003): firms might adopt relatively high returns to tenure to give workers incentives to exert more effort or simply to stay. The consequent tendency toward wage-backloading has also been repeatedly depicted in the literature on labor market contracts (Burdett and Coles, 2003; Shi, 2009; Balke and Lamadon, 2020), but if some industries or occupations experience relatively high mobility of workers, zero or positive correlations may appear between returns to tenure and mobility across firms in equilibrium.

By investigating the actual relationship between wage structures and job mobility, I examine the validity of conventional wisdom. For this, I first estimate the returns to tenure in Korea and the US. In Korea, relatively high returns to tenure, which have been addressed in previous research, are suspected of causing a labor market mismatch that hampers the labor productivity growth of the nation. However, unlike the research on the US labor market, most papers investigating the Korean labor market have failed to consider unobserved heterogeneity using appropriate estimation methods and sufficient data (Hwang *et al.*, 2005; Kim *et al.*, 2015; Park, 2018).

In the current paper, the estimation methods from Altonji and Shakotko (1987) and Topel (1991), which control for unobserved heterogeneity and have been used widely throughout the literature, are employed to overcome these limitations. Furthermore, panel data sets from each country—–the Korean Labor & Income Panel Study (KLIPS) and the US Panel Study of Income Dynamics (PSID)—–are used, details of which will be described later. From the estimations, I determine that Korea has a relatively high return to tenure, while the US is less mobile, which contradicts the conventional wisdom. This may be interpreted as evidence of firms paying a premium for seniority in order to retain workers, as demonstrated in Beffy *et al.* (2006).

To further investigate the returns to tenure in Korea, industry- and occupation-wise returns to tenure are estimated, and it is confirmed that the returns are widely variable across different industries and occupations. Using these estimates, I calculate the correlations between mobility and returns to tenure of different industries and occupations and find that they are slightly positive or almost zero. The findings show that the conventional wisdom of decreasing mobility with increasing returns to tenure may not appear in an equilibrium, possibly because of the role of wages as an incentive device for retaining workers.

The paper proceeds as follows. Section 2 provide a brief review of the literature, Section 3 explains the two main empirical methods for estimation and an overview of the data used, Section 4 presents and analyzes the results, and Section 5 concludes.

2. LITERATURE REVIEW

In this section, I review the related literature, starting with the theoretical explanations that will help in understanding positive returns to employer tenure in a labor market. The most prominent approach is from the human capital theory of Becker (1964), which distinguishes general from specific human capital. Unlike general human capital, which is equally valuable in any firm, specific human capital can only be utilized and accumulated in specific firms and thus contribute to greater firm-specific earnings.

Most other theories focus on the role of positive returns to tenure as an incentive device. For example, in Lazear (1979), it is shown that firms defer payment by paying young workers less and older workers more to solve the agency problem. On the other hand, according to contract theory (Burdett and Coles, 2003;

Shi, 2009; Balke and Lamadon, 2020), firms may use wage-tenure contracts that imply wage increases with employer tenure to incentivize a worker to stay in equilibrium.

Thus, past research suggests a relationship between mobility and wage returns. Other conditions being equal, it is reasonable for a worker to be less mobile as returns to tenure increase, considering firm-specific human capital. However, if we take into account firm heterogeneity and the incentive motives of firms, such that some may have to deal with more mobile workers and have methods to retain them, then an insignificant or positive correlation between returns to tenure and job mobility would also be plausible. In this paper, I explore this possibility.

Empirically, the existence of positive returns to tenure has been repeatedly supported in the literature. Since Altonji and Shakotko (1987) and Topel (1991) started the discussion on estimating returns to tenure by properly controlling unobserved heterogeneity, there have been numerous attempts to decompose wage growth with variations on the estimation methods from the two papers (Altonji and Williams, 2005; Kambourov and Manovskii, 2009; Deelen, 2012). Following the literature, I mainly use the two original methods, and the details are explained in the next section.

Although some papers have explicitly considered job mobility in the estimation of wage returns (Buckinsky *et al.*, 2010), little research has directly investigated the correlation between returns to tenure and job mobility. Of the papers that have, Beffy *et al.* (2006) estimates the returns to tenure in France with the empirical method from Buckinsky *et al.* (2010) and finds that both returns to tenure and job mobility are lower in France than in the US. Additionally, using an equilibrium search model with wage-tenure contracts from Burdett and Coles (2003), the paper explains that the relationship appears because high returns to tenure have a clear incentive effect in high-mobility countries, which is in line with the results of the current research. Another paper that analyzed the correlation is Deelen (2012) which investigates the relationship between wage structure and job changes in the Netherlands and determines that steep wage-tenure profiles are correlated with low mobility. This does not contradict the results of the current paper because the disparity would be due to the differences between two distinct economies. Rather, the results can be interpreted as another useful resource for later comparative studies on international labor markets to help understand the relationship between wage structures and labor market mobility.

In the Korean labor market, there have been repeated attempts to estimate returns to tenure (Ryoo, 2002; Hwang *et al.*, 2005; Lee *et al.*, 2008; Kim *et* *al.*, 2015; Kang *et al.*, 2016; Park, 2018), and much of the research has found them to be relatively high, accusing Korea's unique seniority-based wage system. However, most such papers fail to control for unobserved heterogeneity with appropriate methods or lack sufficient data for a thorough investigation. In the current paper, I adopt two estimation methods and use panel data sets of sufficient volume to overcome these limitations.

3. DATA AND METHODOLOGY

3.1. METHOD

In order to estimate the returns to tenure, I use two different estimation methods, from Altonji and Shakotko (1987) and Topel (1991). Assume that the wage equation to be estimated is

$$w_{ijt} = X_{ijt}\beta_1 + T_{ijt}\beta_2 + \varepsilon_{ijt}.$$

where w_{ijt} is the log real hourly wage of worker i in job j at period t, and X_{ijt} and T_{ijt} denote overall labor market experience and tenure with the employer, respectively. The model also includes dummies for demographic characteristics and a term for the square of labor market experience.

β_1 and β_2 of the wage equation represent returns to experience and tenure. In estimating the returns, unobservable individual- and match-specific components may generate biases; to analyze this issue and to introduce two methods of controlling unobservable components, one can decompose the error term as

$$\varepsilon_{ijt} = \phi_{ijt} + \mu_i + v_{ijt},$$

following Topel (1991). ε_{ijt} is the error term and consists of a match-specific effect ϕ_{ijt}, an individual-specific effect μ_i, and v_{ijt} which accounts for random shocks and measurement error. For example, workers may have different qualities of match with their employers, resulting in different wages, or workers with the same observable characteristics may have different learning abilities. These factors cannot be observed in ordinary survey data, yet it would be reasonable to consider these components to be correlated with tenure or experience. It is well-known that a productive match is less likely to end, and one might therefore argue that the match-specific component ϕ_{ijt} is positively correlated with tenure. Similarly, as a more productive worker would receive higher wages and stay longer in a job, the individual-specific fixed effect might also be positively correlated with tenure.

I will estimate the wage equation first with the OLS. However, the OLS will likely be biased due to the unobserved effects described above. To tackle this problem, I will introduce two estimators from the literature: an instrumental variable (IV) estimator from Altonji and Shakotko (1987) and two-step first-difference (2SFD) estimator form Topel (1991). First, the IV procedure proposed by Altonji and Shakotko (1987) considers the match-specific error to be the fixed "job effects" for each match ($\phi_{ijt} = \phi_{ij}$). Under this assumption, the method uses the deviations of the tenure variables around their means for the sample observations of a given match to be instrumental variables, since they are uncorrelated with either match-specific or individual-specific error components. Specifically, let $\overline{T}_{ij}$ be the mean of tenure for individual i in job j, and let the instrumental variable be $\widetilde{T}_{ijt} = T_{ijt} - \overline{T}_{ij}$. Then, by construction, $\widetilde{T}_{ijt}$ is orthogonal to ϕ_{ij} and μ_i.

In Topel (1991)'s 2SFD, the estimation proceeds in two steps. In the first step, I estimate the combined effect of the experience and tenure terms by applying OLS to the first differences of the wage equation for those who stay, using the fact that fact that $\Delta X = \Delta T = 1$:

$$w_{ijt} - w_{ijt-1} = B + \varepsilon_{ijt} - \varepsilon_{ijt-1},$$

where $B = \beta_1 + \beta_2$. Here, $\varepsilon_{ijt} - \varepsilon_{ijt-1}$ is assumed to have a mean of zero; then, the estimate of average within-job wage growth, $\widehat{B}$, is a consistent estimate. Using this, I can estimate

$$w - T\widehat{B} = X_0\beta_1 + e$$

as the second step, where $e = \varepsilon + T(B - \widehat{B})$. Finally, β_2 is estimated to be $\widehat{B} - \widehat{\beta}_1$.

These are the two most-used methods for estimating returns to tenure in the literature (Altonji and Williams, 2005; Kambourov and Manovskii, 2009; Williams, 2009),[1] and I will estimate the country-, industry-, and occupation-wise returns to tenure using them. As the purpose of the current paper is to compare one representative measure of returns to tenure across different groups, I essentially use only linear terms for employer tenure. However, considering that it is more common in the literature to include higher terms, I also perform regressions with squared terms for tenure, for comparison, although these generate very similar results. I also introduce a quadratic term for education and

[1]Estimates from the IV and 2SFD methods can still be biased, as discussed in Altonji and Williams (2005) and Buckinsky *et al.* (2010). Both methods are known to produce an upward bias in the estimate for β_1 and a downward bias for β_2, but for Topel's 2SFD especially, because the estimate for $\beta_1 + \beta_2$ is unbiased, the author argues that the estimate for β_2 in his method provides a lower bound for returns to tenure.

quadratic and cubed terms for experience, as in Altonji and Shakotko (1987) and Kambourov and Manovskii (2009).

In addition, a marital status dummy, a union dummy, a head-of-household dummy, and one-digit occupation and industry dummies are included in each regression. Details of the industry and occupation specifications are in the next subsection. Finally, for a labor mobility measure of different industries and occupations, I mainly use job-to-job mobility, which I estimate as the proportion of individuals in a group who changed jobs in the subsequent period.

3.2. DATA

I mainly use KLIPS for estimating returns to tenure and job mobility in Korea, which is a longitudinal survey of the Korean labor market and the income activities of households and individuals residing in urban areas. It was started in 1998 and is the longest collection of panel data on Korean individuals, covering a variety of social and economic aspects, from job mobility and unemployment experiences to schooling and health. For the purpose of this research, the data provides rich information about the past jobs each individual has had, making it possible to estimate not only country-level, but also industry- and occupation-wise returns to tenure.

The sample used in this study is from 13 waves of the survey, covering the period from 2004 to 2016. The reason for setting the starting year to be 2004 is because the data provides information on after-tax income only since that year. The sample is restricted to male Koreans aged 18–60, which consists of 6,163 individuals with 45,414 observations after excluding those with unreliable reported data, for example those who disappear in the middle of a job spell. Then I removed observations where the person was not a payed employee with regular working hours (16,754 observations with 1,415 individuals completely removed), worked in the agriculture, fishery, forestry, or mining industries or in related occupations (410 obs., 52 ind.), or worked less than 250 hours a year or earned less than minimum wage (1,475 obs., 151 ind.), leaving 4,545 individuals and 26,775 observations. The wage data used for the study is the log hourly real wage. To deflate the wages, I use the yearly CPI estimates by Statistics Korea.

For industry- and occupation-level comparisons, I use the Korean Standard Industrial Classification (8th) and Korean Standard Classification of Occupations (5th) designed by Statistics Korea and based on the International Standard Industrial Classification of the United Nations and the International Standard Classification of Occupations of the International Labour Organization. Throughout this paper, industry or occupation “sections” denote one-digit classifications and "divisions" denote two-digit classifications. I estimate returns to tenure for both section-level and division-level classifications and use only division-level industries and occupations for investigating the correlations between returns to tenure and labor mobility.

To estimate the returns to tenure in the US and compare with those in Korea, I use PSID, which is the longest running longitudinal household survey in the world with a nationally representative sample of households and individuals living in the US. Began in 1968, the study provides information covering employment, income, education, and numerous other topics and has been used widely in the previous papers estimating returns to tenure (Altonji and Shakotko, 1987; Topel, 1991; Kambourov and Manovskii, 2009; Buckinsky *et al.*, 2010). I employ survey years 2005 to 2017 of the PSID, which cover the same period as the Korean sample. The US sample is also restricted in a similar way to the Korean sample.

For deducting taxes from the US income data, I use TAXSIM32[2]. TAXSIM is the program made by National Bureau of Economic Research for calculating liabilities under US federal and state income tax laws from individual data (Feenberg and Coutts, 1993) and TAXSIM32 is its latest version as of 2021. The program requires state, age, number of dependents, wages, and other individual information to calculate federal and state income taxes. Using the program with the PSID data, I calculated the taxes and deducted from the wages. Finally, the wages are deflated with the CPI estimated by the US Bureau of Labor Statistics.

As noted by Topel (1991) and Buckinsky *et al.* (2010), the tenure variables in the PSID data are not reliable. It is often recorded in large intervals and the values occasionally show inconsistencies between years within one job. To overcome this, I reconstruct the variable using the procedure detailed in both papers. Firstly, for any jobs starting in the panel, tenure starts at zero and grows by 1 for each additional year. Secondly, for jobs that started before the individual appears in the data, current tenure is calculated relative to the maximum reported tenure on the job and, again, it grows by 1 afterward. The same procedure is also conducted for the Korean sample.

Table 1 shows the summary statistics with sample means and standard deviations for the Korean and US samples.

[2]https://taxsim.nber.org/taxsim32/

Table 1: Summary Statistics; KLIPS and PSID; 2004-2016

	Korea		US	
Wage	0.1583	(0.4980)	2.3401	(0.5380)
ΔWage	0.0446	(0.3137)	0.0612	(0.3058)
Tenure	6.2972	(7.4420)	7.3249	(8.1704)
Experience	11.8172	(8.8218)	16.7077	(10.9932)
Education	13.3807	(2.9112)	13.8575	(2.9301)
Head	0.7991	(0.4007)	0.9992	(0.0278)
Married	0.7220	(0.4481)	0.8309	(0.3749)
Union	0.1241	(0.3297)	0.1457	(0.3528)
Individuals	4,545		3,278	
Wage obs.	26,775		11,654	
ΔWage obs.	19,036		6,607	

Notes: KLIPS and PSID samples of employed males aged 18-64. Workers in the agriculture, fishery, forestry, and mining industries and associated occupations and those who worked less than 250 hours a year or earned less than minimum wage are excluded. Wages are log real hourly wages deflated using the CPIs of their respective countries. Wage changes are only for those who stay. Tenure, experience, and education are all measured in years. Standard deviations in parentheses.

4. EMPIRICAL RESULTS

The results are organized as follows: Section 4.1 compares the estimated returns to tenure and job-to-job mobility in Korea and the US, Section 4.2 presents the returns to tenure of each industry and occupation, Section 4.3 shows the correlations between the industry- or occupation-wise returns to tenure with job mobility and discusses the implications, and Section 4.4 investigates possible selection bias that might affect those correlations. The main conclusion is that Korea has higher returns to tenure than the US and, contrary to conventional wisdom, returns to tenure and job mobility in Korea show a slightly positive correlation.

Table 2: Wage Equation Estimates of Korea; OLS and IV

	OLS		IV	
	(1)	(2)	(3)	(4)
Tenure	0.0165***	0.0222***	0.0219***	0.0230***
	(0.0004)	(0.0011)	(0.0010)	(0.0019)
Ten.$^2 \times 10^2$		-0.0230***		-0.0056
		(0.0040)		(0.0064)
Experience	0.0263***	0.0233***	0.0247***	0.0240***
	(0.0020)	(0.0020)	(0.0020)	(0.0022)
Exp.$^2 \times 10^2$	-0.0715***	-0.0604***	-0.0798***	-0.0766***
	(0.0132)	(0.0131)	(0.0137)	(0.0141)
Exp.$^3 \times 10^3$	0.0033	0.0029	0.0048*	0.0046*
	(0.0025)	(0.0025)	(0.0027)	(0.0026)
R^2	0.455	0.456	0.452	0.452
Observations	26,775			

Notes: The dependent variables is the log real hourly wage. Other variables include education variables, a head dummy, a marital status dummy, a union dummy, and section-level industry and occupation dummies. Robust standard errors are in parentheses. * : $p < 0.1$, ** : $p < 0.05$, *** : $p < 0.01$.

4.1. RETURNS TO TENURE AND MOBILITY IN KOREA

The estimates from OLS, IV, and 2SFD are presented in Tables 2 and 3. Columns 1 and 3 of Table 2 and column 1 of Table 3 show the results for the equations with linear tenure terms. As explained in Section 3.1, the 2SFD procedure occurs in two steps, and Table 3 presents those two parts: the first six rows show the results from the first-difference estimation and the next three rows are for the second-step estimation. The last row presents the returns to tenure calculated by the two-step procedure.

In all three estimations, Korea shows higher returns to tenure than the US (see the Appendix), which is consistent with the previous results in the Korean literature, although this is effectively the first attempt to estimate the returns while considering unobserved heterogeneity and using panel data of a sufficient volume. The estimated returns to tenure in Korea are 2.19% in IV method and 2.65% in 2SFD while the estimates are 0.93% and 1.46% for each method in

Table 3: Wage Equation Estimates of Korea; 2SFD

	2SFD	
	(1)	(2)
ΔTenure	0.0759***	0.0759***
	(0.0067)	(0.0067)
ΔTen.$^2 \times 10^2$		0.0065
		(0.0188)
ΔExp.$^2 \times 10^2$	-0.1920***	-0.1960***
	(0.0480)	(0.0502)
ΔExp.$^3 \times 10^3$	0.0251***	0.0252***
	(0.0095)	(0.0095)
R^2	0.022	0.022
Observations	19,036	
Initial exp.	0.0494***	0.0507***
	(0.0004)	(0.0004)
R^2	0.502	0.510
Observations	26,775	
Returns to tenure	0.0265	0.0251

Notes: The first four rows show the first-step estimates of 2SFD. The dependent variable is the change in log wages. Rows 7-9 rows show the second-step estimates. The dependent variable is the log wage minus the estimated tenure and experience terms. Other variables include education variables, a head dummy, a marital status dummy, a union dummy, and section-level industry and occupation dummies. The last row is the estimated returns to tenure. Robust standard errors are in parentheses. * : $p < 0.1$, ** : $p < 0.05$, *** : $p < 0.01$.

the US. The implied 5-year wage growth rate for tenure terms is 11∼13% in Korea and 5∼10% in the US. The estimates for wage growth are in line with the previous literature for both countries (Hwang *et al.*, 2005; Kim *et al.*, 2015; Topel, 1991; Altonji and Williams, 2005).

To further investigate the returns, I also conduct the same exercises with additional squared tenure, which results in similar estimates in terms of scale. These are presented in the even-numbered columns in Table 2 and Table 3. The

Figure 1: Wage-Tenure Profiles; Korea and US; IV and 2SFD

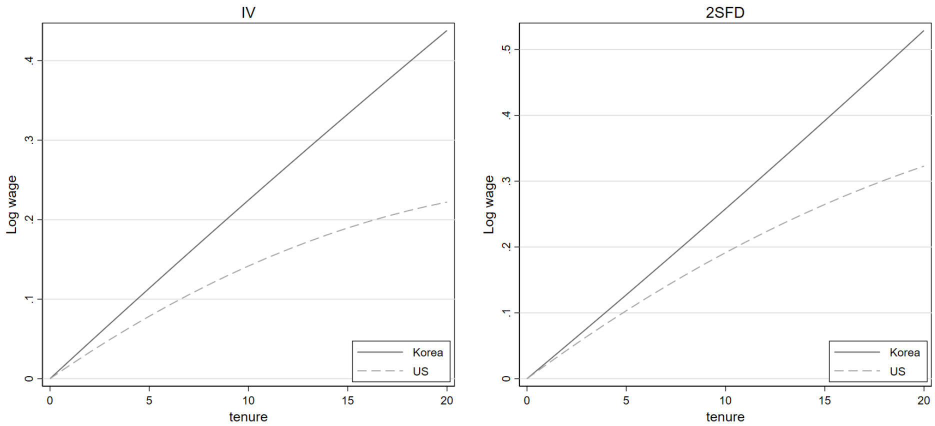

Table 4: Job-to-Job Mobility; Korea and US

Age	Korea		US
$18 \sim 29$	0.1480	$>^{***}$	0.1151
$30 \sim 39$	0.0951	$>^{***}$	0.0751
$40 \sim 49$	0.0621	$>^{**}$	0.0497
$50 \sim$	0.0582	$>^{***}$	0.0319
Total	0.0852	$>^{***}$	0.0701

Notes: Inequalities show the results from paired t-tests. $^{***}: p < 0.01$, $^{**}: p < 0.05$, $^{*}: p < 0.1$.

wage-tenure profiles are plotted in Figure 1 using the linear and squared tenure terms for each estimation method and country. Based on the profiles, it is obvious not only that the linear returns to tenure in Korea are higher than in the US, but also that the curvature of Korea's profile is smaller, meaning that Korean workers experience steadier growth of returns to tenure in the long term than US workers.

Finally, Table 4 presents the job-to-job mobility of different age groups and the overall mobility for both countries. As briefly explained in Section 3.1, job-to-job mobility is measured simply as the proportion of workers who have changed their jobs the following year. In every age group, mobility is higher in Korea than in the US, and paired t-tests show that the differences are statistically significant.

In summary, Korea has higher returns to tenure than the US in both linear wage growth and long-term wage profile with curvature. At the same time, Korea's job-to-job mobility is higher than in the US for each age group and for the overall sample. Although this is only a two-country comparison using different panel data sets, this suggests a possible relationship between job mobility and returns to tenure.

As mentioned above, conventional wisdom has been that job mobility decreases as returns to tenure increase. However, Korea, which has a more mobile labor market than the US, also shows higher returns to tenure, which is in line with the findings in Beffy *et al.* (2006), in which France was found to have lower returns to tenure and lower mobility than the US. Using a job search model with equilibrium wage-tenure contracts introduced by Burdett and Coles (2003), that paper shows that returns to tenure may increase as the mobility rate of workers increases and that this can explain the results of the comparison between France and the US.

The findings in this section may add additional evidence to Beffy *et al.* (2006). However, more thorough analysis that considers workers' mobility decisions and wage contracts would be needed to confirm that the difference in returns to tenure between Korea and the US is due to the difference in mobility.

4.2. RETURNS TO TENURE IN KOREAN INDUSTRIES AND OCCUPATIONS

I now focus on the Korean labor market. In this section, returns to tenure of industries and occupations in Korea are estimated for two purposes. Firstly, although the previous section confirmed that Korea has relatively high returns to tenure, if the industries and occupations have significantly different returns to tenure than each other, it would be more reasonable to look into how the returns vary across different groups to understand the country's overall returns to tenure. Secondly, to investigate the relationship between returns to tenure and job mobility, a comparison between only two countries is not sufficient. As matched employer–employee data to conduct firm-level analysis is currently not available, I address this issue in the next section using different industries and occupations, while the current section provides the necessary estimates and the full picture of the returns to tenure for the final step.

Table 5 and 6 present the industry and occupation section-wise (1-digit level) estimation results for the IV and 2SFD methods. For both estimations in industry analysis, real estate and public administration have relatively high returns to tenure while electricity, gas, and water supply and education have low returns. For occupations, services workers and elementary occupations are high,

Table 5: Returns to Tenure by Industry Section

	IV			2SFD			
	Tenure	Experience	obs.	Tenure	Experience	1st obs.	2nd obs.
Manufacturing	0.0260***	0.0246***	8,065	0.0273§	0.0534***	5,821	8,065
Electricity, gas, and water supply	0.0090	0.0215	218	0.0163	0.0244***	175	218
Construction	0.0120***	0.0189***	4,145	0.0210§	0.0500***	2,947	4,145
Wholesale and retail trade	0.0234***	0.0353***	2,773	0.0225§	0.0465***	1,859	2,773
Accommodation and food service activities	0.0278***	0.0376***	737	0.0412§	0.0529***	395	737
Transportation and storage	0.0248***	0.0100	1,674	0.0304§	0.0729***	1,257	1,674
Information and communication	0.0229	0.0340**	282	0.0335†	0.0458***	211	282
Financial and insurance activities	0.0182***	0.0511***	838	0.0195	0.0243***	624	838
Real estate and renting activities	0.0329***	-0.0259**	654	0.0557	0.0037*	444	654
Business support services	0.0150***	0.0336***	2,556	0.0234§	0.0356***	1,745	2,556
Public administration and defense	0.0410***	0.0235***	1,483	0.0332§	0.0659***	1,207	1,483
Education	0.0117*	0.0294***	1,274	0.0135	0.0136***	957	1,274
Human health and social work activities	0.0265***	0.0401***	563	0.0176‡	0.0647***	386	563
Arts, sports and recreation related services	0.0085	0.0596***	368	0.0251	0.0338***	213	368
Other services	0.0164***	0.0269**	1,145	0.0250§	0.1230***	795	1,145

Notes: Estimates for IV and 2SFD of 15 industry sections. First and second obs. of 2SFD are the observations for the first- and second-step estimations. $^{*}: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$. For the returns to tenure estimates of 2SFD, the superscripts show the statistical significance of the Δtenure estimates in the first step. $^{\dagger}: p < 0.1$, $^{\ddagger}: p < 0.05$, $^{\S}: p < 0.01$.

while professionals and craft workers are low. The returns are also widely variable across divisions (2-digit level). For industry divisions, weighted means and standard deviations of the returns are 0.0323 and 0.1718 in IV, and 0.0236 and 0.1408 in 2SFD. For occupations, they are 0.0118 and 0.1208 in IV, and 0.0262 and 0.0142 in 2SFD.

In a series of pairwise t-tests conducted to further investigate the variance of the returns across the economy, 27% of all possible pairs of industry divisions and 22% of occupation pairs have significantly different IV estimates with one another in 10% level. For 2SFD second stage estimates, the ratios are 82%

Table 6: Returns to Tenure by Occupation Section

	IV			2SFD			
	Tenure	Experience	obs.	Tenure	Experience	1st obs.	2nd obs.
Legislators, senior officials and managers	0.0256***	0.0182	450	0.0231‡	0.0777***	311	450
Professionals	0.0041	0.0386***	3,688	0.0118§	0.0330***	2,697	3,688
Technicians and associate professionals	0.0157***	0.0114*	2,529	0.0276§	0.0650***	1,728	2,529
Clerks	0.0205***	0.0310***	4,778	0.0250§	0.0471***	3,560	4,778
Services workers	0.0411***	0.0454***	1,284	0.0377§	0.0840***	865	1,284
Sales workers	0.0181**	0.0498***	1,060	0.0326†	0.0278***	653	1,060
Craft and related trades workers	0.0185***	0.0209***	5,057	0.0206§	0.0759***	3,649	5,057
Plant and machine operators and assemblers	0.0248***	0.0137***	5,085	0.0296§	0.0497***	3,721	5,085
Elementary occupations	0.0279***	0.0190***	2,844	0.0449§	0.0255***	1,852	2,844

Notes: Estimates for IV and 2SFD of 9 occupation sections. Specifications are the same as for Table 5.

for industry pairs and 63% for occupation pairs. These results imply that there is considerable heterogeneity in the wage structures across different industries and occupations, which may affect the employment and mobility decisions of heterogeneous workers, although this has been frequently ignored in previous research.

4.3. CORRELATIONS BETWEEN RETURNS TO TENURE AND MOBILITY

Using the returns to tenure of industry and occupation divisions estimated in the previous section, I now investigate the relationship between job mobility and returns to tenure in the Korean labor market. Table 7 presents the correlation coefficients between job mobility and returns to tenure of the industry and occupation divisions. For this, the first column uses the proportion of workers who move the following year as a mobility measure, while the remaining columns use the proportions of workers who move the following year among those who satisfy the given conditions. For example, the mobility measure used in the second column is the proportion of those with tenure less than or equal to 1 who move. Divisions with fewer than 200 observations are excluded, leaving 36 industries

Table 7: Correlations between Job Mobility and Returns to Tenure

		Job-to-job mobility of workers with			
	All moves	Ten. ≤ 1	Exp. ≤ 6	Exp. ≥ 10	Age ≥ 40
Industry					
IV	0.0729	0.1978	0.0349	0.1239	0.1277
2SFD	-0.0314	0.0142	-0.0814	0.0359	0.1129
Occupation					
IV	-0.0062	0.3156	0.1828	-0.1547	-0.0051
2SFD	0.2602	0.2707	0.3227	-0.0719	0.0246

Notes: The numbers are correlation coefficients between returns to tenure and the job mobility of industry and occupation divisions. Divisions with fewer than 200 observations are excluded, leaving 35 industries and 23 occupations. The first column use ordinary job-to-job mobility; the second column uses the proportion of workers with tenure ≤ 1 who move the following year as mobility; and the mobility measures for the remaining columns are determined in a similar manner.

and 23 occupations.

The table shows that the correlations are weakly positive or almost zero in most cases. For a robustness check, I also estimate the returns to tenure with the linear tenure term from the wage equations with squared tenure terms as in column 4 of Table 2 and column 2 of Table 3. Under this specification, the correlation coefficients are 0.2091 and 0.1125 for industry-wise IV and 2SFD estimates, respectively, and 0.0775 and 0.2304 for occupation-wise IV and 2SFD estimates, respectively. Considering the number 200 is somewhat arbitrary, I further estimate the original equations for the divisions using cut-offs of 150 and 100 observations, and the resulting correlations are still weakly positive or almost zero.

Similar patterns also appear in the same exercises with different samples. For female samples, the correlation coefficients are 0.4398 and -0.0467 for industry- and occupation-wise 2SFD estimates. When dividing the original male samples by skill levels ("high-skill" for those who have education longer than 12 years, "low-skill" for the others), industry- and occupation-wise coefficients for 2SFD estimates are -0.0586 and -0.0117 in high-skill group and 0.0642 and 0.4304 for low-skill group.

The results contradict the conventional wisdom of decreasing mobility with increasing returns to tenure. All other things being equal, it would be reasonable for a worker to move less as he receives more for staying in a firm. However, with heterogeneous productivity, it is possible that a firm might use returns to tenure as an incentive device to retain workers, which has proven theoretically possible in the previous literature under various conditions (Lazear, 1979; Burdett and Coles, 2003; Balke and Lamadon, 2020). Then, in equilibrium, there may be no or even a positive correlation between returns to tenure and mobility.

4.4. ROBUSTNESS TESTS FOR POSSIBLE SELECTION BIAS

It is possible that the correlations in the previous section are biased: if low-paid workers leave firms more often in some divisions, there may be a selection bias that creates higher returns to tenure for those divisions.

To check whether this is the case, I conduct two exercises. First, for the wage equations used, I add a new variable, "maximum tenure" (*maxten*), which is a worker–job pair-wise maximum value of tenure—or in other words, the length of a match—and estimate the equations using IV and 2SFD. If a selection bias exists, those leaving would be those who had been earning less, at least for the divisions with high returns to tenure, making $\widehat{\beta}_{maxten}$—the coefficient for *maxten*—greater than zero.

Second, the same procedure of estimation in Section 4.1 is performed for long-term workers only, who are defined as those with $maxten \geq 10$ or, in the alternative, $maxten \geq 15$. If the bias were the main source of difference between divisions of high and low returns to tenure, the estimated returns of the divisions with high returns to tenure would be similar to or smaller than those of the low-return divisions when estimated only using long-term workers.

Using the country-level sample, the value of $\widehat{\beta}_{maxten}$ for the first exercise is -0.0025 in IV and -0.0113 in 2SFD, both statistically significant at the 1% level. Furthermore, most of the industries and occupations with high returns to tenure show $\widehat{\beta}_{maxten}$ less than zero. Among the 20 industries and occupations with the highest returns to tenure and with more than 100 observations, only three industries and three occupations have $\widehat{\beta}_{maxten}$ greater than zero. In conclusion, the people leaving early are those who are earning more on average, and this pattern is significant in the divisions with high returns to tenure.

The results for the estimations of long-term workers are presented in Table 8. To compare high-return and low-return divisions, I divide the industry or occupation divisions by those with returns to tenure less than the median (Q_2) and those with returns greater than or equal to the median, and the estimates are given in the first and second columns. I also compare divisions of returns to

Table 8: Estimated Returns to Tenure for Long-Term Workers

	Return to tenure of a division that is ...			
	$< Q_2$	$\geq Q_2$	$< Q_1$	$\geq Q_3$
$maxten \geq 10$				
Industry				
IV	0.0132**	0.0563***	0.0033	0.0653***
2SFD	0.0114***	0.0306***	0.0097***	0.0320***
Occupation				
IV	0.0082	0.0500***	-0.0168	0.0598***
2SFD	0.0111***	0.0278***	0.0024**	0.0292**
$maxten \geq 15$				
Industry				
IV	0.0879***	0.1165***	0.1182**	0.1509***
2SFD	0.0104*	0.0315**	0.0109	0.0324**
Occupation				
IV	0.0782***	0.1352***	0.0241	0.1499***
2SFD	0.0126	0.0292**	0.0061	0.0243

Notes: Q_1, Q_2, and Q_3 are the first, second, and third quartiles, respectively, The first column presents the estimates of long-term workers in the divisions with returns to tenure less than the median (Q_2). The other columns are defined similarly. Two alternative definitions of long-term workers are used: those with maximum tenure greater than 10 year ($maxten \geq 10$) or 15 years ($maxten \geq 15$). For 2SFD, the asterisks are estimates for Δtenure in the first-step estimations. The estimates for the initial variable in the second-step estimations are all significant at the 1% level. * : $p < 0.1$, ** : $p < 0.05$, *** : $p < 0.01$.

tenure smaller than the first quartile (Q_1) with those greater than the third quartile (Q_3) in the third and fourth columns. For each high or low group of divisions, I aggregate the sample of workers with $maxten \geq 10$ or 15 and estimate the returns to tenure with IV and 2SFD. In each case, divisions with higher returns to tenure for the entire sample also have higher returns to tenure for long-term workers.

In summary, there is insufficient evidence to support the notion that those who leave firms in industries or occupations with high returns to tenure earned less before leaving than those who stayed. Furthermore, those who stay long term show a similar pattern of returns to tenure as the entire sample. Therefore, a selection bias caused by those who leave firms is insignificant or implausible.

5. CONCLUDING REMARKS

The current research estimates the returns to tenure in Korea and the US, the returns to tenure of industries and occupations in Korea, and the correlations between mobility and returns to tenure across Korean industries. The results show that, firstly, Korea has higher returns to tenure and mobility than the US; although some papers have estimated the returns to tenure of the Korean labor market, the current research is the first to consider unobserved heterogeneity and to use more than 10 years of panel data. Secondly, the returns to tenure are widely variable across Korean industries and occupations. Finally, the correlations between mobility and returns to tenure are almost zero or even slightly positive, which contradicts the conventional wisdom in which job mobility is expected to decline as returns to tenure increase. Instead, the newly found pattern raises the possibility of returns to tenure being used as an incentive device by firms to retain workers.

Limitations such as a lack of consideration of endogenous decision-making and insufficient control over industry- and occupation-specific traits mean that the analysis in the current research is insufficient to understand the mechanisms behind wage structures and job mobility in an economy. The findings, however, should motivate further research to investigate labor market dynamics. More specifically, a structural model that includes both firm heterogeneity and the endogenous mobility decisions of workers would help with understanding the relationship between labor market mobility and the wage dynamics of an economy.

APPENDIX

In this section, I present the tables of estimation results for the US sample from OLS, IV, and 2SFD, which would be analogous to Table 2 and Table 3. All the specifications are the same as the tables with the Korean sample.

Table A1: Wage Equation Estimates of the US; OLS and IV

	OLS		IV	
	(1)	(2)	(3)	(4)
Tenure	0.0073***	0.0138***	0.0093***	0.0172***
	(0.0006)	(0.0015)	(0.0008)	(0.0021)
Ten.$^2 \times 10^2$		-0.0243***		-0.0307***
		(0.0050)		(0.0064)
Experience	0.0445***	0.0418***	0.0435***	0.0403***
	(0.0030)	(0.0030)	(0.0030)	(0.0031)
Exp.$^2 \times 10^2$	-0.1370***	-0.1300***	-0.1370***	-0.1280***
	(0.0168)	(0.0169)	(0.0167)	(0.0168)
Exp.$^3 \times 10^3$	0.0121***	0.0120***	0.0119***	0.0118***
	(0.0027)	(0.0027)	(0.0027)	(0.0027)
R^2	0.432	0.434	0.432	0.433
Observations	11,654			

Table A2: Wage Equation Estimates of Korea; 2SFD

	2SFD	
	(1)	(2)
ΔTenure	0.0991***	0.0997***
	(0.0078)	(0.0078)
ΔTen.$^2 \times 10^2$		-0.0300**
		(0.0132)
ΔExp.$^2 \times 10^2$	-0.3170***	-0.3040***
	(0.0397)	(0.0404)
ΔExp.$^3 \times 10^3$	0.0362***	0.0362***
	(0.0060)	(0.0060)
R^2	0.061	0.062
Observations	6,607	
Initial exp.	0.0845***	0.0787***
	(0.0005)	(0.0005)
R^2	0.755	0.733
Observations	11,654	
Returns to tenure	0.0146	0.0209

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