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SIGNALING EFFECTS OF LAYOFFS IN SOUTH KOREA*

Taehoon Kim

Department of Economics, Kyung Hee University
Seoul 02447, Korea
tkim@khu.ac.kr

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Abstract

I examine an asymmetric-information model of layoffs (Gibbons and Katz, 1991) by comparing changes in earnings of laid-off workers and displaced workers by plant closings using Korean data. The estimation result shows that laid-off male workers experience 11.5% greater earnings losses than those displaced by plant closings. Laid-off workers also have longer unemployment spells. Contrary to previous studies, the signaling effect of layoffs is observed not only in white-collar but also blue-collar occupations in South Korea. The seniority-based wage payment system and low unionization rate in South Korea are suggested as possible reasons for this unique finding.

Keywords: layoff, plant closing, signaling, union, seniority
JEL Classification Codes: J30, J31, J63, J64

I. *Introduction*

I test an asymmetric-information model of layoffs (Gibbons and Katz, 1991) by comparing changes in earnings of laid-off workers and displaced workers by plant closings using Korean data and compare the results to those from research on other countries. In their model, all workers initially receive an average wage according to their expected value of productivity because of incomplete information on the abilities of individual workers. After employers observe the abilities of their workers, they retain workers of high ability and lay off workers of low ability. This sends signals about the abilities of the workers to potential employers in the labor market who have less information on the abilities of workers, and laid-off workers have lower wages in post-displacement jobs as a result.

This model provides a testable prediction that workers displaced by layoffs experience greater earnings losses than those displaced by plant closings since potential employers in the labor market conjecture that laid-off workers have low abilities while they cannot exactly infer the abilities of workers displaced by plant closings as all workers lose jobs. The larger earnings

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losses of laid-off workers should be from lower wages in post-displacement jobs and wages of laid-off workers and displaced workers by plant closings should be similar in pre-displacement jobs according to the model.

Gibbons and Katz (1991) empirically test the model using the U.S. data and find that the signaling effect of layoffs is observed in white-collar but not blue-collar jobs. According to them, this result may be due to the fact that unionization rate is high in blue-collar jobs so that firms with blue-collar jobs may have less authority to decide whom to lay off as blue-collar jobs are more likely to be affected by collective bargaining agreements including layoff-by-seniority rules. This can weaken the signaling effect of layoffs in blue-collar jobs. Doiron (1995) examines the signaling effect of layoffs in the Canadian labor market. Her main finding is that workers displaced by layoffs experience larger earnings losses only in white-collar jobs regardless of union status. She explains that the non-existence of the signaling effect of layoffs in blue-collar jobs may be due to the characteristics of blue-collar jobs and not the high unionization rate. Grund (1999) explores the German market and finds no evidence for the signaling effect of layoffs. Several German labor market institutions are highlighted as possible reasons for the result. Hu and Taber (2011) test the signaling model for a broader group of workers including black and female workers while only white male workers are in the sample of Gibbons and Katz (1991). Hu and Taber (2011) find that the signaling effect of layoffs is only observed for white male workers. For black and female workers, workers displaced by plant closings experience greater earnings losses.

These studies imply that the signaling effect of layoffs can differ by subgroups of workers and by labor market institution. I supplement evidence on the signaling effect of layoffs from the Korean labor market and provide a distinctive finding that differs from the previous studies. The OLS estimation result shows that laid-off male workers experience 11.5% greater earnings losses than those displaced by plant closings. The earnings difference between laid-off workers and displaced workers by plant closings is small and insignificant in pre-displacement jobs and laid-off workers have 10.9% lower monthly earnings in post-displacement jobs. These results are exactly consistent with the prediction of the signaling model. My unique finding is that the signaling effect of layoffs is also large in blue-collar jobs in South Korea. The earnings losses of laid-off workers in blue-collar jobs are 9.1% greater than those of workers displaced by plant closings. It is 15.1% for white-collar jobs. I also estimate the effect of layoffs using propensity score matching (PSM) and the PSM estimates are comparable to the OLS estimates. For female workers, the significant effect of layoffs on earnings losses is not found, while laid-off workers have lower earnings in both pre-displacement and post-displacement jobs than workers displaced by plant closings.

I interpret the results that the signaling effect of layoffs exists for male workers in both white-collar and blue-collar jobs as stemming from the wage payment system that is based on seniority and the low unionization rate in the Korean labor market. The wage payment system is based on seniority and the unionization rate is low in both blue-collar and white-collar jobs in South Korea, while the unionization rate is much higher in blue-collar jobs than in white-collar jobs in the U.S. and the Canadian labor markets (Gibbons and Katz, 1992, Doiron, 1995). The seniority-based wage-payment system increases the pressure on firms to lay off unproductive senior workers and this can lead to social agreements that allow employers to have authority to decide whom to lay off considering the system. In addition, the low unionization rate prevents layoff rules from being determined by collective bargaining agreements including layoff-by-seniority rules.

Several robustness tests and subgroup analyses are conducted for male workers. A sample selection problem can arise in the above estimations because only displaced workers who were re-employed after displacement are included in the sample. Three robustness tests for sample selection including the Heckman two-step model are conducted to investigate whether the selection problem seriously distorts the estimates. The results from the robustness tests show that the sample selection is not likely to bias the estimates.

I examine whether there exist alternative hypotheses that can explain the empirical evidence. Krashinsky (2002) argue that laid-off workers experience greater earnings losses because they lose wage premiums from large firms. He finds that the effect of layoffs on earnings losses is substantially reduced when the size of the pre-displacement firm is controlled. However, controlling the firm size effect barely changes the estimation results in this study in contrast to Krashinsky (2002). I also test whether differential health losses after displacement between laid-off workers and workers displaced by plant closings can explain the results. The inclusion of a health change variable before-and-after displacement does not significantly affect the estimation results.

The earnings losses by layoffs compared to plant closings tend to be greater for displaced workers from non-union firms and those with more pre-displacement tenure and higher age at displacement. These results are consistent with the premise of the signaling model that the signaling effect of layoffs is greater when layoffs contain more information on the abilities of workers. The Weibull regression result also shows that laid-off male workers in white-collar jobs have a longer unemployment spell than those displaced by plant closings. In conclusion, the empirical evidence in South Korea is consistent with the prediction of the signaling model.

II. *Data*

I use the Korean Labor and Income Panel Study (KLIPS) for the analysis. The KLIPS started to survey 5,000 households in non-rural areas in 1998, and the data on the surveys 1-15 are used in this study. The KLIPS surveys detailed information on the labor market experience and outcomes, education, and demographic characteristics of individuals. I restrict the sample to workers who lost their jobs due to layoffs or plant closings, were aged between 19-60 at displacement, were hired as full-time and regular workers in private firms before displacement.[1] 558 male workers displaced by layoffs or plant closings are in the sample and 510 workers among them were ever re-employed after displacement. There are 376 female displaced workers in the sample and 280 workers among them were ever remployed.[2] All displaced workers are in

[1] Full-time workers are defined as those who work 36 hours or more a week. Regular workers means full-time workers who make a contract without a fixed term and an employer directly employs.

[2] Section 1 of Article 23 of the Labor Standards Act does not allow employers with 5 or more employees to lay off workers without a legitimate reason. The Act does not specify what the legitimate reasons are. It is, however, considered that the legitimate reasons include a loss of ability to work, a lack of eligibility, low performance, disobedience of obligation in contract, falsehoods in an application, and misdeeds. Employers can lay off workers when they face a crisis or do restructuring as well (Korean Society of Labor Law, 2018). For employers with 4 or less employees, the rule that a layoff is possible when legitimate reasons exist is not required although there are requirements about a notice of a layoff and a timing of it. Does the Korean government stronlgy regulate layoffs

the sample in the analysis of the Heckman two-step model and the duration analysis. On the other hand, only the re-employed workers are in the sample in other analyses. While I also conduct analysis for female displaced workers, I mostly focus on male workers since it is considered that female labor force participation rate is low and a lot of female workers experience career breaks possibly because of marriage, childbirth, and child rearing in South Korea.[3]

Table 1 reports the summary statistics for displaced male workers by cause of displacement.[4] Laid-off workers experience larger earnings losses than those displaced by plant closings. They experience an 18.3% reduction in monthly earnings while workers displaced by plant closings experience a 7.2% reduction. This difference comes mainly from substantially lower post-displacement earnings for laid-off workers. While (log) monthly earnings before displacement are 5.03 and 5.02 for workers displaced by plant closings and layoffs, respectively, their post-displacement earnings are 4.96 and 4.82. Unemployment spells after displacement are also longer for laid-off workers. Laid-off workers experience 9.83 months of unemployment duration after job losses on average, while workers displaced by plant closings experience 9.07 months of unemployment duration. It is more likely that laid-off workers are employed in larger firms before displacement than workers displaced by plant closings. The difference in the firm size disappears after re-employment. These results are consistent with the findings of Krashnsky (2002) that laid-off workers are employed in larger firms before displacement and the difference in the firm size vanishes after displacement in the U.S.

One notable characteristic in Table 1 is that laid-off workers are older and more experienced at displacement than those displaced by plant closings. The mean experience of laid-off workers is 21.35 years at displacement, while it is 18.54 years for workers displaced by plant closings. The mean age of laid-off workers is 39.24 years old and workers displaced by plant closings is 36.87 years old. Laid-off workers also have longer tenure in pre-displacement firms than workers displaced by plant closings by 1.16 years. These statistics are in opposition to those in the United States and Germany, where laid-off workers have less experience and tenure than workers displaced by plant closings. In the United States, the mean experience (tenure) of laid-off workers at displacement is 11.23 (3.72) while it is 13.67 (5.87) for workers

compared to other countries? The OECD releases the Employment Protection Legislation Index, which is useful to compare flexibility or rigidity of the labor market across different countries. It provides detailed indices which include the level of protection of permanent workers against individual and collective dismissals, the level of protection of permanent workers against (individual) dismissal, and the level of specific requirements for collective dismissal. For the level of protection of permanent workers against individual and collective dismissals, South Korea is ranked 13th among 34 countries. The index in 2013 is 2.17, 2.09, 2.98, and 1.17 for South Korea, Japan, Germany, and the U.S., respectively. The OECD average is 2.29. The higher index means the protection level is higher. For the level of protection of permanent workers against (individual) dismissal, the index is 2.29 in South Korea, while the OECD average is 2.04. For the level of specific requirements for collective dismissal, the index is 1.88, 3.25, 3.63, and 2.88 for South Korea, Japan, Germany, and the U.S., respectively, and the OECD average is 2.91. Kwon (2015) summarizes that the protection level in South Korea is relatively low among the OECD countries, while the protection of permanent workers against (individual) dismissal is slightly higher.

[3] Female labor force participation rate is low in South Korea compared to the OECD countries. It is 58.4, 68.1, 67.3% in South Korea, Japan, and the U.S., respectively, and the OECD average is 63.6% in 2016 (source: 2017 OECD Employment Outlook).

[4] The summary statistics for female displaced workers and non-displaced workers are reported in Table A1 and A2 in the Appendix. Displaced workers have less earnings, experience, and tenure on average than non-displaced workers.

Table 1. Summary Statistics for Displaced Male Workers by Cause of Displacement

	Whole Sample	Plant Closing	Layoff
Change in log monthly earnings	-0.107	-0.075	-0.202
	(0.425)	(0.425)	(0.414)
Log monthly earnings before displacement	5.03	5.03	5.02
	(0.431)	(0.414)	(0.481)
Log monthly earnings after displacement	4.92	4.96	4.82
	(0.478)	(0.460)	(0.515)
Unemployment spell (months)	9.21	9.07	9.83
	(13.43)	(15.49)	(10.53)
Experience at displacement	19.29	18.54	21.35
	(10.59)	(10.12)	(11.56)
Tenure in the pre-displacement job	4.75	4.45	5.61
	(5.08)	(4.83)	(5.70)
Age at displacement	37.47	36.87	39.24
	(9.14)	(8.82)	(9.88)
Years of education	12.75	12.94	12.17
	(2.70)	(2.55)	(3.06)
Occupation (White=1)	0.513	0.558	0.380
	(0.500)	(0.497)	(0.487)
Union	0.100	0.069	0.202
	(0.300)	(0.254)	(0.404)
Firm size in the pre-displacement firm	0.255	0.216	0.374
(# of employees>99)	(0.436)	(0.412)	(0.486)
Firm size in the post-displacement firm	0.232	0.231	0.234
(# of employees>99)	(0.423)	(0.422)	(0.425)
Observations	510	510	510

Notes: 1. Standard deviations are in parenthesis. 2. Monthly earnings (Korean Won) are deflated by the GDP deflator and they are divided by 10,000. The above figures are the natural logarithms of them. 3. 307 workers answered the question whether their pre-displacement firm had a union. For other variables, the sample size is 510.

displaced by plant closings (from Table 1 and 2 of Gibbons and Katz (1991)). Krashinsky (2002) also reports statistics from the NLSY that laid-off workers have shorter tenure and experience than workers displaced by plant closings in the U.S. In Germany, the mean experience (tenure) of laid-off workers is 19.98 (6.05) while it is 21.2 (9.89) for workers displaced by plant closings (from Table A.1 of Grund (1999)) The summary statistics for these variables are not reported in the Canadian Study. These results may imply that layoff decisions are affected by seniority rules, which protect senior workers against permanent layoff, in the U.S. and the German labor markets so that workers with lower tenures are more likely to be laid off. On the other hand, the higher averages of age, experience, and tenure of laid-off workers than displaced workers by plant closings mean that layoff decisions are not likely to be governed by seniority rules in South Korea.

It is often pointed out that the wage-payment system in South Korea is based more on seniority than on performance in many firms, which means that the wages of workers tend to increase automatically as their tenure increases (Jung, 2002, Hwang, 2005). Hwang (2005) explains that not only is wage payment based on seniority in Korean firms but also is the personnel system, which reinforces the determination of wages based on seniority.[5] This seniority-based wage-payment system can lead firms to lay off older and longer-tenured workers

[5] Is the wage-payment system in South Korea really based on seniority? I discuss it in more detail in the Appendix.

who earn high wages but lack the comparable productivity.[6] The tendency of firms preferring to lay off senior workers is also confirmed in Supreme Court precedents. Jung (2002) reports a Supreme Court precedent where the court acknowledges the legitimacy that employers use age, tenure, and work performance as three criteria to decide whom to lay off and lay off older, higher tenure, and low-performance workers. He quotes the Supreme Court precedent which states that, "we can understand the employer's criteria as rational and fair criteria in the situation that the defendant bank judged that the number of laid-off workers can be minimized by laying off older and longer tenured workers holding high positions considering the distinctive seniority-based wage-payment system in our country". This confirms again the fact that the seniority-based wage-payment system may widely affect the criteria for selecting laid-off workers in firms in South Korea. Jung (2002) also reports other cases where firms use seniority as a layoff criterion and lay off workers with high tenure. He argues that the Supreme Court in South Korea broadly and considerably acknowledges the authority of employers to set the criteria and evaluation weight of each component in the determination of laid-off workers.

Table 1 also presents that 10.0% of the displaced workers responded that there was a union in their pre-displacement firm, which is comparable to the administrative data. The administrative data in the Korea Statistical Yearbook also reports that the average unionization rate during the sample periods 1995-2012 is 11.3%. In comparison to the Canadian labor market, where the unionization rate is 29.5% (Doiron, 1995), the unionization rate is low in South Korea during the sample period. The seniority-based wage-payment system and the low unionization rate are the key institutional characteristics that allow firms not to adopt external layoff rules such as seniority rules and give employers the authority to determine whom to lay off. This argument is supported by the fact that age, experience, and tenure of laid-off workers are greater on average than displaced workers by plant closings, which is the opposite to the cases in the United States and Germany.

Table 2 reports the summary statistics by cause of displacement for white-collar and blue-collar occupations, respectively. For white-collar occupations, laid-off workers experience 24.6% earnings losses compared to 8.0% for workers displaced by plant closings. Laid-off workers receive 19.8% greater monthly earnings before displacement compared to those displaced by plant closings and they have 3.0% lower earnings in post-displacement jobs. For blue-collar occupations, the earnings reduction for laid-off workers is 14.1% and 6.2% for those displaced by plant closings. Workers displaced by layoffs receive 8.3% lower earnings in pre-displacement firms than workers displaced by plant closings, and laid-off workers have 18.5% lower earnings in post-displacement firms. In contrast to the results in the previous research, Table 2 clearly shows that laid-off workers experience greater earnings losses than workers displaced by plant closings. This is found not only in white-collar occupations but also in blue-collar occupations in South Korea.

Another notable fact in Table 2 is that laid-off workers are more experienced and tenured, even in blue-collar occupations. For blue-collar occupations, the average experience (tenure) at displacement is 19.83 (4.85) years for workers displaced by plant closings and 22.62 (5.63) years for laid-off workers. For white-collar occupations, the average experience (tenure) at

[6] Hwang (2005) shows that the relative wage of workers whose ages are 35-54 to workers whose age is below 35 is 1.73 while their relative productivity is 1.05. In addition, the relative wage of workers who are older than 54 to workers who are younger than 35 is 3.02 while their relative productivity is 0.6.

Table 2. Summary Statistics for White-collar and Blue-collar Male Workers by Cause of Displacement

	White Collar		Blue Collar	
	Plant closing	Layoff	Plant closing	Layoff
Change in log monthly earnings	-0.083 (0.425)	-0.282 (0.463)	-0.064 (0.425)	-0.152 (0.374)
Log monthly earnings before displacement	5.10 (0.422)	5.28 (0.478)	4.95 (0.388)	4.87 (0.413)
Log monthly earnings after displacement	5.02 (0.484)	4.99 (0.616)	4.88 (0.417)	4.71 (0.412)
Unemployment spell (months)	10.04 (17.79)	9.84 (8.29)	7.83 (11.92)	9.82 (11.74)
Experience at displacement	16.42 (9.31)	18.53 (9.49)	19.83 (10.20)	22.62 (12.47)
Tenure in the pre-displacement job	4.14 (4.22)	5.59 (4.68)	4.85 (5.48)	5.63 (6.27)
Age at displacement	36.21 (8.44)	38.52 (8.52)	37.71 (9.22)	39.67 (10.66)
Years of education	13.78 (2.45)	13.99 (2.63)	11.87 (2.26)	11.06 (2.76)
Union	0.046 (0.209)	0.249 (0.441)	0.098 (0.299)	0.177 (0.386)
Firm size in the pre-displacement firm (# of employees>99)	0.248 (0.433)	0.478 (0.505)	0.175 (0.382)	0.306 (0.464)
Firm size in the post-displacement firm (# of employees>99)	0.237 (0.427)	0.285 (0.456)	0.223 (0.418)	0.202 (0.404)
Observations	201	52	173	84

Notes: 1. Standard deviations are in parenthesis. 2. Monthly earnings (Korean Won) are deflated by the GDP deflator and they are divided by 10,000. 3. The above figures are the natural logarithms of them. 4. 307 workers answered the question whether their pre-displacement firm had a union. For other variables, the sample size is 510.

displacement is 16.42 (4.14) years for displaced workers by plant closings and 18.53 (5.59) years for laid-off workers. This is a very different result from the case in the U.S. that shows laid-off workers have lower tenure and experience at displacement, and the gap is greater for blue-collar workers. In the United States, laid-off workers have 3.07 and 2.57 years shorter experience and tenure at displacement than those displaced by plant closings for blue-collar occupations. For white-collar occupations, laid-off workers have 1.22 and 1.33 years shorter experience and tenure at displacement (from Table 2 of Gibbons and Katz, 1991). The statistics in Table 2 clearly show that layoffs are not likely to be governed by seniority rules even in blue-collar occupations in South Korea.

Table 2 also shows that the unionization rate is lower and the difference in the unionization rate between blue-collar and white-collar jobs is much smaller in South Korea than in the United States and Canada for the samples in the studies. The unionization rates are 9.5% in white-collar jobs and 12.6% in blue-collar jobs in the sample. In the U.S., the ratios were 10.4% in white-collar jobs and 38.5% in blue-collar jobs in 1983 (from footnote 13 of Gibbons and Katz (1991)). In Doiron (1995), the unionization rates are 9.0% in white-collar jobs and 36.5% in blue-collar jobs in the Canadian labor market (from Table 1 of her paper). Gibbons and Katz (1991) argue that the signaling effect of layoffs would be greater when firms have more authority to decide whom to layoff. Since the unionization rate is higher in blue-collar jobs, layoffs in blue-collar jobs can be more determined by collective bargaining agreements including seniority rules than in white-collar jobs. In their research, laid-off workers experience greater earnings losses than workers displaced by plant closings only for white-collar jobs, while the signaling effect of layoffs is not observed for blue-collar jobs. If this is the case, it is expected that the signaling effect of layoffs can exist in both white-collar and blue-collar jobs in South Korea as the seniority-based wage-payment system and the low unionization rate in both occupations lead to the environment that allow employers to have enough authority to decide whom to lay off.

III. *Empirical Method*

1. Regression

We use the following regression model to estimate the signaling effect of layoffs.

$$Y_i = \beta_0 + \beta_1 D_i + X_i \beta_2 + \varepsilon_i \tag{1}$$

where Y_i denotes three outcome variables which are the change in logged monthly earnings before-and-after job displacement, the log of monthly earnings in the pre-displacement job and that in the post-displacement job of an individual i. D_i is a dummy variable that indicates whether or not the cause of displacement is a layoff (D_i is 1 if an individual i is a laid-off worker and 0 if he is a displaced worker by plant closings) and X_i is a vector of controlling variables including years of education, a dummy for marital status, dummies for father's job status at age 14 (regular worker, irregular worker, employer with employees, self-employed without an employee, family business worker, and unemployed), a dummy that indicates whether a male worker has passed the medical test for the mandatory military service in South Korea[7], potential experience at displacement and its square, dummies for occupations in pre-displacement job, industry dummies, and dummies for the year of displacement.

The main parameter of interest is β_1, which represents the effects of layoffs on the earnings variables compared to displacement by plant closings after controlling all demographic and job characteristics of individuals. The signaling model predicts that laid-off workers have lower earnings than workers displaced by plant closings after displacement, while they have similar earnings before displacement given other characteristics are equal. The coefficient of the layoff dummy variable, therefore, is predicted to be negative for the change in earnings before-and-after displacement and post-displacement earnings, and insignificant for pre-displacement earnings.

2. Matching

I also estimate the effect of layoffs compared to plant closings on the earnings variables using propensity score matching. Under the conditional independence assumption ($Y_1, Y_0 \perp D_i | X_i$), comparing treatment and control groups conditional on covariates provides the conditional

[7] All South Korean males take a conscription examination at age 19 and those who have passed the medical test should serve in the military. The variable indicates health status of a worker at age 19 because an individual's failure of the test means that the individual has a health problem.

average treatment effect.

$$\begin{aligned}\Delta(X_i) &\equiv E[Y_i \mid D_i=1, X_i] - E[Y_i \mid D_i=0, X_i] \\ &= E[Y_i(1) \mid D_i=1, X_i] - E[Y_i(0) \mid D_i=0, X_i] \\ &= E[Y_i(1) - Y_i(0) \mid X_i] \\ &= \text{ATE}(X_i) \qquad (2)\end{aligned}$$

We can estimate the average treatment effect by computing the conditional average treatment effect for all X_i and then weighting them. The propensity score theorem (Rosenbaum and Rubin, 1983) shows that we can circumvent the dimensionality of the covariates by matching the propensity score ($\text{P}(D_i=1 \mid X_i)$) rather than all covariates.

Both regression and matching rely on the conditional independence assumption for causal interpretation of the estimate. I extensively control covariates and interpret the estimate as the effect of layoffs compared to plant closings on the earnings variables after controlling all the covariates.[8]

IV. *Results*

1. The Effects of Layoffs on the Earnings Variable

Panel (a) of Table 3 reports the OLS and the PSM estimation results for all displaced male workers, white-collar, and blue-collar male workers, respectively. For the entire sample, laid-off male workers experience 11.5% greater earnings losses than those displaced by plant closings, and this is mostly from their lower wage in the post-displacement firm in the OLS estimation. While the difference in monthly earnings between laid-off workers and workers displaced by plant closings is estimated to be just 0.7%, laid-off workers have 10.9% lower earnings in post-displacement jobs. The corresponding estimates from the PSM are 11.5%, 0.3%, and 11.5%, which are comparable to the OLS estimates. In contrast to the previous studies, laid-off workers in blue-collar jobs experience higher earnings losses than those displaced by plant closings in South Korea. The earnings losses of laid-off workers in blue-collar jobs are 9.2(11.4)% greater than those of workers displaced by plant closings, and they have 13.9(15.1)% less earnings in their post-displacement firm in the OLS(PSM) estimation. This is a uniquely observed result as more wage reduction by layoffs than plant closings is not found in blue-collar jobs in other countries. For workers in white-collar jobs, laid-off workers have 15.1% greater earnings losses in the OLS estimation and 12.8% in the PSM estimation.

Table 4 presents the results for female workers. Laid-off female workers have lower earnings in both pre-displacement and post-displacement firms in the OLS estimation. While

[8] On the other hand, regression and matching are similar for a binary treatment variable. They are different only in the weights used to combine the conditional average treatment effect into a single average treatment effect. Propensity score matching puts more weight on observations with values of X for which the propensity score is large, while regression puts more weight on observations with values of X for which the numbers of treated and controlled individuals are similar (Angrist and Pischke, 2009). Since the main variable of interest is a binary variable in this study, the difference between regression and matching is not crucial.

Table 3. Effects of Layoffs on Change in Earnings, Earnings in the Pre-displacement Firm, and Earnings in the Post-displacement Firm: Male Workers

		(1) Change in log earnings	(2) Pre-displacement log earnings	(3) Post-displacement log earnings
(a)All workers	OLS	-0.122*** (0.045)	0.007 (0.036)	-0.115*** (0.044)
	PSM	-0.122*** (0.044)	-0.0003 (0.045)	-0.122*** (0.052)
(b)Blue collar	OLS	-0.096* (0.058)	-0.054 (0.050)	-0.150*** (0.051)
	PSM	-0.121** (0.060)	-0.043 (0.042)	-0.164*** (0.057)
(c)White collar	OLS	-0.164** (0.073)	0.099* (0.054)	-0.065 (0.075)
	PSM	-0.137*** (0.046)	-0.020 (0.040)	-0.117*** (0.045)

Notes: 1. *** p<0.01, ** p<0.05, * p<0.10. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates. For the PSM, displacement year dummies are not controlled to satisfy the common support condition.

Table 4. Effects of Layoffs on Change in Earnings, Earnings in the Pre-displacement Firm, and Earnings in the Post-displacement Firm: Female Workers

		(1) Change in log earnings	(2) Pre-displacement log earnings	(3) Post-displacement log earnings	N
(a)All workers	OLS	-0.014 (0.049)	-0.080* (0.045)	-0.094* (0.052)	280
	PSM	-0.008 (0.047)	-0.026 (0.046)	-0.034 (0.057)	280
(b)Blue collar	OLS	0.016 (0.081)	-0.032 (0.076)	-0.017 (0.074)	130
	PSM	-0.032 (0.034)	-0.053 (0.056)	-0.085 (0.061)	130
(c)White collar	OLS	-0.020 (0.068)	-0.115* (0.059)	-0.135* (0.076)	150
	PSM	-0.005 (0.070)	-0.137** (0.061)	-0.133 (0.092)	150

Notes: 1. *** p<0.01, ** p<0.05, * p<0.10. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, dummies for father's job status at age 14 are included as covariates. For the PSM, displacement year dummies are not controlled to satisfy the common support condition.

earnings of blue-collar laid-off workers do not significantly differ from earnings of displaced workers by plant closings, laid-off workers in white-collar job have significantly lower earnings in both pre-displacement and post-displacement firms than workers displaced by plant closings.

As the earnings gap of laid-off workers and workers displaced by plant closings are similar in the pre-displacement and post-displacement firms, however, any significant effect of layoffs on earnings losses is observed for female workers regardless of estimation method and pre-displacement occupation. These are different from the case in the U.S. where female workers displaced by plant closings experience greater earnings losses than laid-off female workers (Hu and Taber, 2011).

For later analyses, I focus on male workers because the effect of layoffs on earnings losses is clear only for them. I also report results for earnings losses and omit results for earnings in pre-displacement and post-displacement firms to simplify analysis and discussion.

2. Robustness Tests for Sample Selection Problem

The estimation results for male workers in Table 3 are consistent with the prediction from the signaling model. However, sample-selection bias can exist in the estimates because workers who are re-employed after displacement are only included in the sample. I conduct three robustness tests to check whether the sample-selection problem significantly affects the estimates. The results of the robustness tests are reported in Table 5. Panel (a) of Table 5 reports the results for the subsample of workers whose age is 50 and lower. It is likely to be more difficult for older workers to find a new job after displacement than younger workers so that the proportion of displaced workers who are not re-employed after displacement can be greater among older workers.[9] The OLS estimate for all workers shows that laid-off workers have 11.7% greater earnings losses than workers displaced by plant closings. The corresponding PSM estimate is 12.4%. For blue-collar workers, the OLS and the PSM estimates are -0.072 and -0.069, respectively, and they are not statistically significant. For white-collar workers the OLS and the PSM estimates are -0.202 and -0.131.

Panel (b) of Table 5 presents the results for the subsample of workers who were displaced at least 2 years before the last survey date. The subsample includes workers who had a sufficient time to find a new job considering 9.2 months of the average unemployment spell in Table 1. The OLS and PSM estimates for all workers are -0.155 and -0.130. The OLS and the PSM estimation results for blue-collar and white-collar workers also show the significant effect of layoffs on earnings losses.

The third test is the Heckman two-step selection model. Heckman's two-step model is a method that is commonly used for handling bias from nonrandom selected sample. It consists of two equations which are an outcome equation and a selection equation, respectively. The selection equation here describes how displaced workers are re-employed. The Heckit method corrects the selection bias by controlling the inverse Mills ratio computed from probit estimates of the selection equation. We also need to have an exclusion restriction in the selection equation for estimating the Heckman model well because the inverse Mills ratio can be highly correlated with regressors and this can lead to large standard errors of the estimates.[10] I estimate the model using the numbers of sons and daughters as exclusion restrictions for the employment equation. The estimation results of the Heckman two-step model are reported in

[9] This is consistent with data. Among workers who were displaced at age 50 and younger, 7.2% of the workers are not re-employed. It is 19.4% among workers whose age at displacement is over 50.

[10] See Wooldridge (2015) for more detailed explanation of the selection model.

TABLE 5. EFFECT OF LAYOFFS ON CHANGE IN EARNINGS: ROBUST TESTS FOR SAMPLE SELECTION: MALE WORKERS

	(1) All workers	(2) Blue collar	(3) White collar
(a)Age: 50 or younger			
OLS	-0.124***	-0.072	-0.202***
	(0.047)	(0.067)	(0.071)
PSM	-0.132***	-0.069	-0.131**
	(0.043)	(0.065)	(0.062)
(b)Displaced at least 2 years Before the survey date			
OLS	-0.155***	-0.131**	-0.185***
	(0.045)	(0.061)	(0.071)
PSM	-0.130***	-0.110*	-0.169***
	(0.049)	(0.063)	(0.058)
(c)Heckman Two-Step model			
	-0.116***	-0.110**	-0.127*
	(0.043)	(0.054)	(0.067)

Notes: 1. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates. For the PSM, displacement year dummies are not controlled to satisfy the common support condition.

Panel (c) of Table 5. The estimated effect of layoffs on earnings losses is -0.116, -0.110, and -0.127 for all workers, blue-collar workers, and white-collar workers, respectively. The results of the robustness tests for the sample selection problem show that the sample selection is not likely to seriously bias the estimates of the signaling effect of layoffs.[11]

V. *Signaling Effect of Layoffs by Union Status, Tenure, and Age*

The regression results for male workers in Tables 3 consistently show that layoffs lead to greater earnings losses than displacement by plant closings, even in blue-collar jobs. Why do the results in South Korea differ from those in other countries? First explanation is that the unionization rate is low not only in white-collar jobs but also in blue-collar jobs in South Korea. Many firms with blue-collar jobs may also have the authority to choose whom to lay off in South Korea because of the low unionization rate; the decision is likely to be based on factors such as employee performance evaluations and the gap between productivity and wages, not rules determined by collective bargaining agreements. This can strengthen the signaling effect, even in blue-collar occupations. Second explanation is that the wage payment system in South Korea is largely based on seniority. This means that firms can have more incentive to lay off workers with high tenure and low productivity because low-productivity workers have similar wages to high-productivity workers due to their seniority in pre-displacement firms under the seniority-based wage-payment system. If this is the case, there could be social

[11] The sample selection problem is likely to be greater for female workers than male workers. I also estimate the effect of layoffs using the Heckman two-step model for female workers. Even though the magnitude of the estimated effect becomes greater, the estimate is still statistically insignificant.

Table 6. Effect of Layoffs on Change in Earnings: Male Workers Displaced by Non-union Firms

	(1) All workers	(2) Blue collar	(3) White collar
OLS	-0.124***	-0.072	-0.202***
	(0.047)	(0.067)	(0.071)
PSM	-0.132***	-0.069	-0.131**
	(0.043)	(0.065)	(0.062)

Notes: 1. *** p<0.01, ** p<0.05, * p<0.10. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates. For the PSM, displacement year dummies are not controlled to satisfy the common support condition.

agreements that allow employers to have the authority to determine whom to lay off as seen in the Supreme Court precedents in Section 2. In the labor market with these institutions, layoffs can transmit a strong signal to the labor market in both occupations. I investigate whether these explanations are consistent with data by analyzing how the signaling effect of layoffs varies by union status, age at displacement, and job tenure at displacement, respectively.

First, I estimate the signaling effect of layoffs for workers displaced from a non-union firm. The regression result is not reported for workers who were displaced from a union firm because sample size is too small (34 observations).[12] Table 6 shows that workers who were laid off from a firm without a union experience 17.8(9.0)% greater earnings losses than those displaced by plant closings in the OLS(PSM) estimation. For blue-collar workers, the estimated effect of layoff on earnings change is -15.8(-11.9)% in the OLS(PSM) estimation. This result is different from Doiron (1997) that the signaling effect of layoffs is not found in blue-collar jobs regardless of unionization. For white-collar workers, those laid-off experience 24.9 (25.3) % greater earnings losses than workers displaced by plant closings in the OLS(PSM) estimation. The estimates of the signaling effect tend to be greater for workers who were displaced from non-union firms than those for all displaced workers in Table 3. This is consistent with the interpretation from Gibbons and Katz (1991) that the magnitude of the signaling effect is greater for workers displaced from non-union firms because employers in non-union firms have more authority over whom to lay off so that layoffs from them have more information.

As noted in Gibbons and Katz (1991), the longer an employer observes the abilities of workers, the stronger the signal that is likely to be transmitted to the market. This predicts that laid-off workers with high tenure in the pre-displacement firm can have a greater signaling effect than those with low tenure. I test whether the signaling effect of layoffs differs by tenure in the pre-displacement firm. I make two tenure dummies-low tenure and high tenure, where low tenure means that it is less than or equal to 5 years and high tenure means that it is greater than 5 years.

The estimates on the interactions of the layoff dummy and the tenure dummies are

[12] If I briefly mention the result, the signaling effect of layoffs is not found for displaced workers from a unionized firm, which is consistent with the prediction from Gibbons and Katz (1991). The estimate is 0.015 for displaced workers from a unionized firm and it is not statistically significant. The displacement year dummies are not controlled for this regression because of small sample size.

Table 7. Effect of Layoffs after High Tenure and Low Tenure on Change in Earnings: Male Workers

	(1) All workers	(2) Blue collar	(3) White collar
Low tenure×Layoff	-0.063	-0.045	-0.105
	(0.055)	(0.067)	(0.094)
High tenure×Layoff	-0.195***	-0.249***	-0.157
	(0.068)	(0.092)	(0.102)
Observations	273	139	134

Notes: 1. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates.

reported in Table 7. Table 7 shows that layoffs after high tenure generate larger earnings losses as predicted. The estimation result for the entire sample shows that workers who were laid off after low tenure periods experience 6.1% earnings losses, while the value is 17.7% for layoffs after high tenure. For blue-collar workers, layoffs after high tenure generate 22.0% greater earnings losses than plant closings. The estimated effect is 4.4% for blue-collar workers with low tenure. For white-collar occupations, laid-off workers after high tenure experience 14.5% earnings losses. Workers displaced by layoffs after low tenure experience 10.0% earnings losses.

Third, I investigate how the signaling effect of layoffs differ by age group. In the seniority-based wage-payment system, earnings losses can be greater for older laid-off workers whose discrepancy between productivity and wage is large. I divide workers by four groups according to age at displacement. Table 8 first reports the proportion of the number of laid-off workers to that of all displaced workers by age group. It shows that the proportion tends to be larger for workers of greater age. The ratio is 23.7, 21.9, 30.7, and 36.9% for workers who were displaced at age 19-29, 30-39, 40-49, 50-60, respectively. This is consistent with the argument that employers may have more incentive to lay off workers of greater age under the seniority-based wage-payment system. The OLS estimation results are also reported in Table 8. Even though all estimates are statistically insignificant, the absolute value of the estimate is larger for workers in the group of greater age. The estimate of the layoff effect for all workers is -0.046, -0.098, -0.121, and -0.294 for each group in the order of age.

Panel (b) and (c) of Table 8 show the results for blue-collar and white-collar workers, respectively. The ratio of laid-off workers tends to be larger for workers of greater age. This is important because layoff decision is not likely to be governed by seniority rules even for blue-collar workers in South Korea. This may be because the unionization rate is low in blue-collar jobs and employers have a larger incentive to lay off older workers under the seniority-based wage-payment system. The OLS estimation results also show that the signaling effect of layoffs tends to be greater for older workers. For blue-collar workers who were displaced at age 50-60, laid-off workers have 21.8% greater earnings losses than workers displaced by plant closings and the estimate is statistically significant at 5%. For white-collar workers, the ratio also tends to be larger for workers of greater age, but the relationship is less clear than blue-collar workers. The magnitude of the signaling effect is the greatest for workers displaced at age 50-60 (-0.561), however it is not statistically significant, possibly because of small sample

TABLE 8. EFFECT OF LAYOFFS ON CHANGE IN EARNINGS BY AGE GROUP: MALE WORKERS

Age group	Ratio of laid-off workers	OLS estimate	Observations
(a)Whole workers			
19≤age<30	0.237	-0.046 (0.101)	118
30≤age<40	0.219	-0.098 (0.084)	187
40≤age<50	0.307	-0.121 (0.096)	140
50≤age<60	0.369	-0.294 (0.209)	65
(b)Blue-collar workers			
19≤age<30	0.305	-0.039 (0.114)	59
30≤age<40	0.269	0.092 (0.108)	78
40≤age<50	0.327	-0.105 (0.101)	78
50≤age<60	0.476	-0.246*** (0.114)	42
(c)White-collar workers			
19≤age<30	0.170	-0.121 (0.157)	59
30≤age<40	0.184	-0.276** (0.107)	109
40≤age<50	0.290	-0.063 (0.130)	62
50<age<60	0.174	-0.561 (0.468)	23

Notes: 1. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates. For regressions by occupation, industry, occupation, physical examination result, father's job status, and displacement year dummies are not controlled to satisfy the common support condition.

size. For workers displaced at age 30-39, the estimate is -0.276 and it is statistically significant at a 5% level.

VI. *Alternative Explanations*

Even though the estimation results are consistent with the prediction of the asymmetric information model of layoffs, I check whether there are alternative explanations that are also consistent with the empirical evidence. I empirically test three alternative explanations. The first alternative explanation by Krashnsky (2002) is that laid-off workers experience larger earnings losses because they lose a wage premium from working in larger firms before displacement. When the economy is hit by a negative shock, it is more likely that smaller firms shut down and larger firms lay off workers. As larger firms tend to pay a higher wage than smaller firms and laid-off workers are more likely to be detached from larger firms than those displaced by

TABLE 9. EFFECT OF LAYOFFS ON CHANGE IN EARNINGS AFTER CONTROLLING FIRM SIZE: MALE WORKERS

	(1) All workers	(2) Blue collar	(3) White collar
OLS	-0.125**	-0.106*	-0.171**
	(0.049)	(0.064)	(0.080)
PSM	-0.116***	-0.102	-0.111**
	(0.033)	(0.064)	(0.050)
Observations	461	229	232

Notes: 1. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates. For the PSM, displacement year dummies are not controlled to satisfy the common support condition.

plant closings, laid-off workers can experience greater earnings losses. Krashnsky (2002) finds that the negative earnings effect of layoffs is substantially reduced or disappears when the firm size, which is measured by the number of employees, is controlled.

As investigated in Tables 1 and 2, laid-off workers are more likely to be employed in larger firms before displacement than workers displaced by plant closings and the difference disappears after re-employment in South Korea. This is consistent with the findings in Krashnsky (2002) and it is worth investigating whether the firm size effect accounts for much of the earnings losses of laid-off workers. I test whether the estimate for the effect of layoffs substantially changes when the firm size is controlled. Table 9 reports the estimation results for all workers, blue-collar workers, and white-collar workers. The sample size is smaller because there are missing values for the firm size. The firm size is categorized into five groups and five dummy variables corresponding to each firm size category, which are produced for the pre-displacement firm and post-displacement firm, respectively. 25 five dummy variables, which are interactions of pre-displacement and post-displacement firm size dummies, are controlled in the regression. In contrast to Krashnsky (2002), I find no evidence that controlling the firm size significantly changes the estimate for the effect of layoffs. For all workers, the OLS (PSM) estimate is -0.125(-0.116) when the firm size dummies are controlled. The OLS(PSM) estimate is -0.106(-0.102) for blue-collar workers and -0.171(-0.111) for white-collar workers. Most of the estimates are statistically significant. It is not likely that the losses of wage premium from large firms after layoffs can explain the larger earnings losses of laid-off workers than workers displaced by plant closings in the Korean labor market.

The second alternative explanation is by a matching model (Gibbons and Katz, 1991). They suggest the alternative explanation that some workers of low ability are initially employed in industries that require high ability because of imperfect information, but workers of low ability are laid off as their abilities are revealed, causing them to move to different industries that do not require high ability workers. As a result, they receive low wages in the post-displacement firms. This is different from the asymmetric information model as this does not necessarily require asymmetric information between the current employer and potential employers. Following Gibbons and Katz (1991), I test the hypothesis by additionally including a dummy variable that indicates whether a worker's industry has changed after displacement and an interaction term between the industry change dummy and the layoff dummy. According

Table 10. Effect of Layoffs and Change in Health on Change in Earnings: Male Workers

	(1)	(2)
Layoff	-0.101	-0.117
	(0.081)	(0.080)
Change in health		-0.091**
		(0.038)
Observations	161	161

Notes: 1. *** p<0.01, ** p<0.05, * p<0.10. 2. Standard errors are in parenthesis. 3. A layoff dummy, dummies for education levels, dummies for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement are included as covariates.

to the model, the coefficient on the interaction term should be negative in the regressions for earnings change and post-displacement earnings.

Table 10 reports the estimation results for all workers, blue-collar workers, and white-collar workers. Laid-off workers have greater earnings losses and this is mostly from their lower earnings in the post-displacement firms. It also shows that workers who change industry experience substantial earnings losses and have lower earnings in post-displacement firms. However, laid-off workers who change industries do not have a wage penalty in post-displacement firms. The coefficient on the interaction between the industry change dummy and the layoff dummy is statistically insignificant for all groups. The matching model is not consistent with the empirical evidence as in Gibbons and Katz (1991).

Third alternative explanation is that the larger earnings losses of laid-off workers may reflect a greater reduction in the productivity of laid-off workers after displacement.[13] For example, a job loss can be detrimental to health and many recent studies substantiate the relation (Black, Devereux, and Salvanes, 2015, Browning and Heinesen, 2012, Eliason and Storrie, 2009). Even though laid-off workers experience greater earnings losses, displaced workers by plant closings also experience large earnings losses as seen in Tables 1 and 2. The literature on the negative effect of a job loss on health raises the possibility that the earnings losses can occur through health loss after displacement. In addition, tf layoffs aggravate health more than plant closings, laid-off workers can experience larger earnings losses through this channel. I investigate whether the effect of layoffs is still negative after controlling a change in health after job displacement. The KLIPS has surveyed self-evaluated health from the 6th survey and the answer consists of five items from very healthy which is scored as 1 to very unhealthy which is scored as 5. I make a variable that measures the deterioration of health after displacement which is a gap between self-evaluated health surveyed a year before job displacement and that surveyed in the year of re-employment. For example, if a worker answered that he is very healthy (1) a year before displacement and he is unhealthy (4) in the year of re-employment, the variable has a value of 3.

I estimate the equation (1) again controlling the health variable additionally. Because health related questions started to be surveyed from the 6th survey, sample size is substantially reduced when the health variable is controlled. For the sample that answered self-evaluated

[13] This analysis is indebted to a referee.

health, the estimate for the layoff effect is -0.101 when the health change variable is not controlled and it is -0.117 when the variable is controlled. The estimated coefficient of the health change variable is -0.091 and it is statistically significant at 5% level. This means that earnings reduces by 8.7% when a worker reports that his self-reported health gets worse by one in the scale. The inclusion of the health change variable does not significantly affect the estimated effect of layoffs on earnings losses.

VII. *Unemployment Spells*

Finally, I test whether laid-off workers experience longer unemployment spells after displacement than workers displaced by plant closings. For this, I estimate the Weibull accelerated failure time model for unemployment spells after displacement following Gibbons and Katz (1991). The estimation results are reported in Table 11. I report the estimation results that additionally control pre-displacement earnings. Whether it is controlled barely changes the estimation results.

Column (1) reports the estimation result for all workers and shows that laid-off workers have 23.7% longer unemployment spells than those displaced by plant closings. It is not statistically significant. For blue-collar workers in column (2), laid-off workers experience 1.0% longer unemployment spells and it is also not statistically significant. For white-collar workers in column (3), laid-off workers have 48.2% longer unemployment spells and it is statistically significant at a 10% level. Even though the average unemployment spell of laid-off white-collar workers is only slightly shorter than those displaced by plant closings among workers who find a job after displacement in Table 2, it is estimated that they experience longer unemployment spells because the proportion of workers who do not find a job during the

TABLE 11. THE EFFECT OF LAYOFFS, INDUSTRY CHANGE, AND LAYOFFS WITH INDUSTRY CHANGE ON CHANGE IN EARNINGS: MALE WORKERS

	(1) All workers	(2) Blue collar	(3) White collar
(a) Change in log earnings			
Layoff	-0.086	-0.095	-0.105
	(0.065)	(0.084)	(0.106)
Industry change	-0.112**	-0.133*	-0.081
	(0.046)	(0.068)	(0.069)
Layoff × Industry change	-0.025	0.055	-0.122
	(0.090)	(0.114)	(0.158)
(b)Post-displacement log earnings			
Layoff	-0.098	-0.172**	0.006
	(0.064)	(0.076)	(0.108)
Industry change	-0.154***	-0.124**	-0.150**
	(0.046)	(0.062)	(0.070)
Layoff × Industry change	0.009	0.087	-0.141
	(0.088)	(0.104)	(0.161)

Notes: 1. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience and its squares at displacement, tenure and its squares in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates.

TABLE 12. THE EFFECT OF LAYOFFS, EXPERIENCE, TENURE, AND PRE-DISPLACEMENT EARNINGS ON UNEMPLOYMENT SPELLS: THE WEIBULL ACCELERATED FAILURE TIME MODEL: MALE WORKERS

	(1) All workers	(2) Blue collar	(3) White collar
Layoff	0.237	0.010	0.482*
	(0.172)	(0.199)	(0.293)
Experience	0.050***	0.049***	0.039**
	(0.012)	(0.015)	(0.015)
Previous tenure	0.034**	0.020	0.075***
	(0.017)	(0.015)	(0.026)
Pre-displacement earnings	-0.397*	-0.262	-0.622**
	(0.233)	(0.301)	(0.360)
p (Shape parameter for the Weibull Hazard function)	0.703*** (0.032)	0.825*** (0.035)	0.722*** (0.033)
Observations	559	274	283

Notes: 1. *** p<0.01, ** p<0.05, * p<0.10. 2. Standard errors are in parenthesis. 3. A layoff dummy, years of education, a dummy for marital status, potential experience at displacement, tenure in the previous firm, occupations dummies, industry dummies and dummies for the year of displacement, physical examination result for military service, dummies for father's job status at age 14 are included as covariates.

sample period is higher for laid-off white-collar workers. The estimation results also show that years of experience and tenure are positively correlated with unemployment spells. It is estimated that workers who have higher earnings in pre-displacement firms experience shorter unemployment spells. All the estimation results are consistent with the findings in Gibbons and Katz (1991) and Nakamura (2008).

VIII. *Conclusion*

I show that laid-off male workers experience larger earnings losses and longer unemployment spells than workers who are displaced by plant closings in the Korean labor market. Both the OLS and the PSM estimations provide consistent results. The unique finding in this study is that the larger earnings losses of laid-off workers are observed not only in white-collar jobs but also in blue-collar jobs. The robustness tests for the sample selection problem including the Heckman two-step model provide comparable results with those from the model that does not consider the sample selection problem. The sample selection problem is not likely to distort the estimation results seriously. The results are consistent with the asymmetric model of layoffs, while there are empirical facts that do not reconcile with the alternative models. The signaling effect of layoffs tend to be greater for displaced workers from non-union firms and with higher tenure and age at displacement.

Two distinctive institutions in the Korean labor market, the low unionization rate and the seniority-based wage-payment system, are provided as possible institutional factors for the signaling effect of layoffs in both white-collar and blue-collar jobs. These two institutions allow employers to have enough authority to decide whom to lay off. This can strengthen the signaling effect of layoffs in both blue-collar and white-collar occupations in South Korea.

Appendix

In the Appendix, I report summary statistics for female workers and non-displaced workers, respectively, and analysis for age-earnings profile in South Korea. Table A1 presents summary statistics for female workers by cause of displacement. It shows that laid-off female workers experience greater earnings losses than workers displaced by plant closings on average. The average earnings losses in pre-displacement and post-displacement firms are also lower for laid-off workers. The average unemployment spell of laid-off workers is greater than that of displaced workers by plant closings. In contrast to male workers, female workers who were displaced by plant closings are older and more experienced at displacement than laid-off female workers. Female laid-off workers are more likely to be displaced from non-union firms and to be white-collar workers in the pre-displacement firm than workers displaced by plant closings.

Table A2 presents summary statistics for non-displaced workers in the KLIPS by gender. Non-displaced workers have greater earnings than displaced workers on average. The means of experience, tenure, and age are greater for non-displaced workers. The proportion of white-collar workers is greater for non-displaced workers. They are also more likely to work in unionized large size firms. These relationships hold for both male and female workers.

It is considered that the wage-payment system in South Korea has been largely based on seniority. I empirically investigate the argument by comparing age-earnings profiles in South Korea and the U.S. I use the following data for analysis: the EAPS (Economically Active Population Survey) August Supplement for South Korea and the CPS Outgoing Rotation Group for the U.S. The sample period is 2001-2017 when is a commonly available period for both data. Since Korean data that is comparable to the CPS is the EAPS, I use it for comparison.[14]

I estimate the following Mincer earnings equation to understand how earnings vary according to age in the two countries.

$$E_{it}=\gamma_0+\mathrm{f}(age_{it})+X_{it}\gamma_1+\delta_t+\varepsilon_{it} \tag{A1}$$

where E_{it} is the logarithm of earnings, age_{it} is age, X_{it} is a vector of regressors that includes a marital status dummy and five dummies of education level of an individual i in year t, δ_t presents time fixed effects, and ε_{it} is an error term. $\mathrm{f}(age_{it})$ is any function of age. I estimate the model for South Korea and the U.S., respectively.

I first estimate the standard form of the Mincer earnings model that assumes the age function is quadratic. Table A3 reports the estimation results by gender and education. I devide workers into two education groups. The first group is workers with high school or lower education and the other group is workers with some college or more education. The estimation results show that the estimated coefficient on age is greater in South Korea for male workers in both education groups. The magnitude of the estimated coefficient on squared age is also greater in South Korea. For female workers, the relationship differs by education group. The absolute values of the estimates are lower in South Korea for female workers with high school education or lower education, while they are larger in South Korea for female

[14] Lagakos et al. (2018) compare experience-wage profiles across countries. They use the Census and the ACS for the U.S. and the KLIPS for South Korea. However, Jung (2002) argue that data with similar structure and large sample size should be used for comparison of the experience-earnings profiles across different countries. This is the reason why I use the EAPS and the CPS for comparison.

Table A1. Summary Statistics for Displaced Female Workers by Cause of Displacement

	Whole Sample	Plant Closing	Layoff
Change in log monthly earnings	-0.005 (0.347)	0.012 (0.333)	-0.045 (0.377)
Log monthly earnings before displacement	4.46 (0.367)	4.48 (0.368)	4.40 (0.359)
Log monthly earnings after displacement	4.46 (0.416)	4.50 (0.392)	4.35 (0.460)
Unemployment spell (months)	12.48 (21.86)	10.75 (21.06)	16.85 (23.33)
Experience at displacement	18.26 (13.48)	18.64 (13.35)	17.30 (13.84)
Tenure in the pre-displacement job	3.25 (3.30)	3.15 (3.18)	3.51 (3.60)
Age at displacement	35.71 (10.99)	36.11 (10.96)	34.72 (11.07)
Years of education	11.45 (3.44)	11.47 (3.46)	11.42 (3.41)
Occupation (White=1)	0.552 (0.498)	0.514 (0.501)	0.647 (0.481)
Union	0.052 (0.223)	0.038 (0.192)	0.102 (0.306)
Firm size in the pre-displacement firm (# of employees>99)	0.374 (0.486)	0.322 (0.471)	0.518 (0.508)
Firm size in the post-displacement firm (# of employees>99)	0.378 (0.487)	0.397 (0.493)	0.337 (0.479)
Observations	280	196	84

Notes: 1. Standard deviations are in parenthesis. 2. Monthly earnings (Korean Won) are deflated by the GDP deflator and they are divided by 10,000. The above figures are the natural logarithms of them.

Table A2. Summary Statistics for All Workers in the Klips by Gender

	Male	Female
Log monthly earnings	5.29 (0.549)	4.75 (0.574)
Experience	20.51 (11.13)	18.76 (12.85)
Tenure	6.67 (7.35)	4.60 (5.95)
Age	39.82 (9.84)	37.24 (8.82)
Years of education	13.31 (3.07)	12.48 (3.32)
Occupation (White=1)	0.480 (0.500)	0.577 (0.494)
Union	0.240 (0.427)	0.152 (0.359)
Firm size (# of employees>99)	0.545 (0.498)	0.529 (0.499)
Observations	35,679	23,341

Notes: 1. Standard deviations are in parenthesis. 2. Monthly earnings (Korean Won) are deflated by the GDP deflator and they are divided by 10,000. The above figures are the natural logarithms of them.

workers with some college or more education.

As the assumption that the age function is quadratic could be strong, I also estimate the model without imposing a specific functional form on the relationship between (log) earnings and age. I estimate

TABLE A3. THE EFFECTS OF AGE AND SQUARED AGE ON EARNINGS IN SOUTH KOREA AND U.S.

	Korea	U.S.
Male workers		
(a)All		
Age	0.0964***	0.0640***
	(0.0009)	(0.0004)
$Age^2/10$	-0.0104***	-0.0067***
	(0.0001)	(0.00005)
Observations	169,414	1,118,725
(b) High school and lower		
Age	0.0689***	0.0479***
	(0.0013)	(0.0005)
$Age^2/10$	-0.0077***	-0.0048***
	(0.0002)	(0.0001)
Observations	83,101	445,335
(c) Some college and more		
Age	0.1111***	0.0810***
	(0.0014)	(0.0005)
$Age^2/10$	-0.0117***	-0.0085***
	(0.0017)	(0.0001)
Observations	86,313	673,390
Female workers		
(a)All		
Age	0.0474***	0.0553***
	(0.0010)	(0.0004)
$Age^2/10$	-0.0057***	-0.0056***
	(0.0001)	(0.0001)
Observations	113,654	927,086
(b) High school and lower		
Age	0.0198***	0.0359***
	(0.0013)	(0.0006)
$Age^2/10$	-0.0027***	-0.0034***
	(0.0002)	(0.0001)
Observations	68,790	293,387
(c) Some college and more		
Age	0.0762***	0.0657***
	(0.0019)	(0.0005)
$Age^2/10$	-0.0091***	-0.0068***
	(0.0003)	(0.0001)
Observations	44,864	633,699

Notes: 1. Data: EAPS for South Korea and CPS ORG for U.S. 2. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. 3. Standard errors are in parenthesis.

the model using Robinson's semiparametric regression (1988) and report the nonparametric fit of the age-earnings profile. Figure A1 and A2 show the age-earnings profiles by education group for male and female workers, respectively.[15] The values in the y-axis present the relative earnings at each age to that at age 20 and the earnings at age 20 are set to be 1. The relative earnings are constructed based on the nonparametric estimates. For male workers in Figure A1, earnings grow faster at earlier ages, but they decline much faster after the early fifties in South Korea than in the U.S. The similar pattern is observed in both education groups. This is consistent with Lagos et al. (2018) that shows the sharpest decline in earnings at older ages in South Korea among developed countries.

[15] To reduce the estimation time, I use 20% random sample of the U.S. data. I check whether the estimates from the parametric model change significantly when the 20% random sample is used and find that the estimates barely change.

Figure A1. Nonparametric Age-Earnings Profile of Male Workers by Education Level in South Korea and U.S.

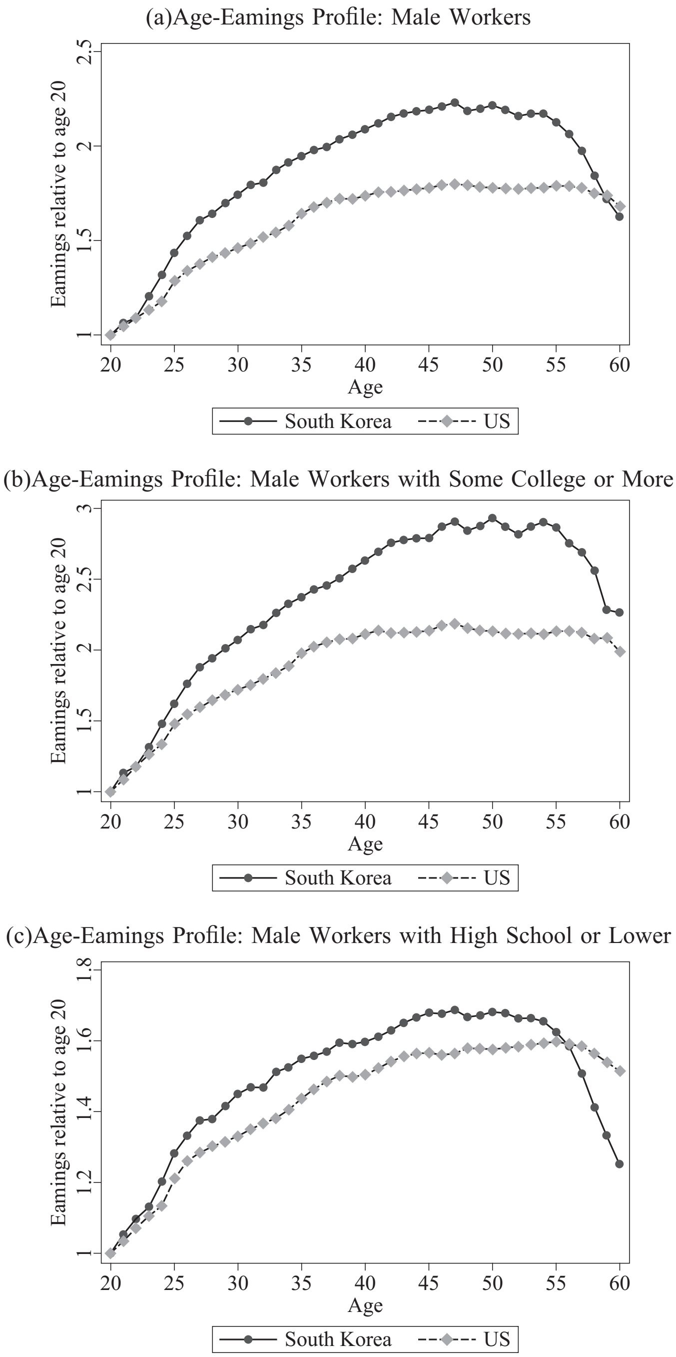
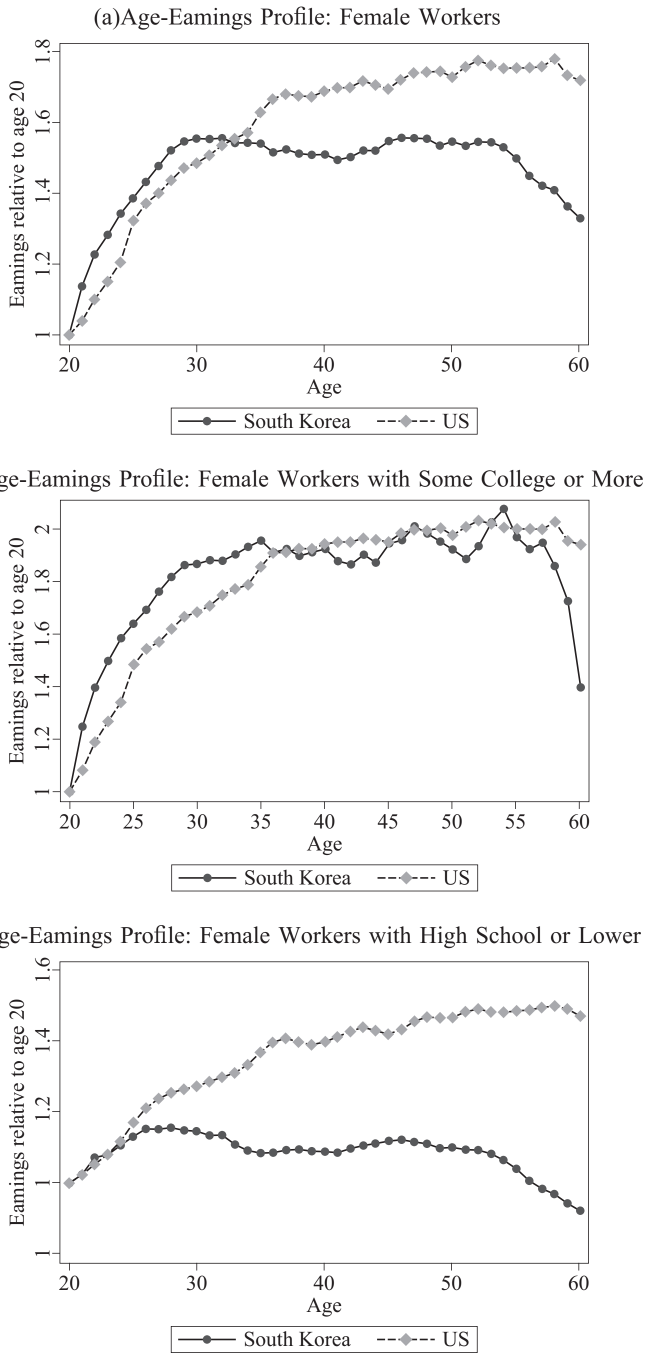


FIGURE A2. NONPARAMETRIC AGE-EARNINGS PROFILE OF FEMALE WORKERS BY EDUCATION LEVEL IN SOUTH KOREA AND U.S.



For female workers in Figure A2, the earnings grow faster till the late twenties in South Korea than in the U.S. The earnings are flat after the late twenties and decrease sharply after the early fifties in South Korea, while the earnings constantly increase until the late fifties in the U.S. The earnings relative to those at age 20 are greater in the U.S. after the early thirties. The age-earnings profiles are relatively similar in South Korea and the U.S. for female workers with some college or more education except for the drastic decrease in earnings in the late fifties in South Korea. The striking difference is observed for female workers with high school or lower education. The earnings gradually decrease after the mid-twenties in South Korea, while they constantly increase in the U.S.

Lagakos et al. (2018) suggest that human capital accumulation, search and matching frictions, and long-term wage contracts are possible theories that can explain differential life cycle earnings profiles across different countries. Even though investigating the reasons for the difference in the age-earnings profiles in South Korea and the U.S. is beyond the scope of this paper, the steeper earnings growth for male workers in South Korea is consistent with the explanation that long-term wage contracts can play an important role for shaping the steeper age-earnings profile. It is possible that the age-earnings profile for male workers is steeper in South Korea because the seniority-based wage-payment system is a form of long-term wage contracts and it is more prevalent in South Korea. The steeper age-earnings profile for male workers in South Korea may be suggestive evidence of the prevalence of the seniority-based wage-payment system in South Korea.[16]

References

Abraham, K. and J.L. Medoff (1984), "Length of Service and Layoffs in Union and Nonunion Work Groups," *Industrial and Labor Relations Review* 38, pp.87-97.

Angrist, J.D. and J. Pischke (2009), *Mostly Harmless Econometrics*, New Jersey, Princeton University Press.

Black, S.E., P.J. Devereux. and K.G. Salvanes (2015), "Losing Heart? The Effect of Job Displacement on Health," *Industrial and Labor Relations Review* 68, pp.833-861.

Browning, M. and E. Heinesen (2012), "Effect of Job Loss Due to Plant Closure on Mortality and Hospitalization," *Journal of Health Economics* 31, pp.599-616.

Cho, Y. (2002), *A Study on Selection Criteria for People to Be Laid Off Due to Management Problems,* Seoul, Korea Labor Institute (in Korean).

Doiron, D.J. (1995), "Layoffs as Signals: The Canadian Evidence," *Canadian Journal of Economics* 28(4a), pp.899-913.

Eliason, M. and D. Storrie (2009), "Job Loss is Bad for Your Health – Swedish Evidence on Cause-Specific Hospitalization Following Involuntary Job Loss," *Social Science & Medicine* 68, pp.1396-1406.

Gibbons, R. and L.F. Katz (1991), "Layoffs and Lemons," *Journal of Labor Economics* 9, pp.351-380.

Grund, C. (1999), "Stigma Effects of Layoffs? Evidence from German Micro-data," *Economics Letters* 64, pp.241-247.

Heckman, J.J. (1979), "Sample Selection Bias as a Specification Error," *Econometrica* 47,

[16] A number of career breaks of female workers and the low female labor force participation may explain the flatter age-earnings profile for female workers in South Korea.

pp.153-161.
Hwang, S.K. (2005), "Rethink Seniority-Based Wage," in: Korea Labor Institute, eds., *Labor Review Vol.2*, Seoul, Korea Labor Institute, pp.1-12 (in Korean).
Hu, L. and C.R. Taber (2011), "Displacement, Asymmetric Information, and Heterogeneous Human Capital," *Journal of Labor Economics* 29, pp.113-152.
Jung, E. (2002), "Is Korea a Country of Long-term Employment and Seniority-Based Wage?" *Economy and Society* 53, pp.262-288 (in Korean).
Korean Society of Labor Law (2018), *Educational Labor Law*, Gyeonggi, Moonwoosa (in Korean).
Krashinsky, H. (2002), "Evidence on Adverse Selection and Establishment Size in the Labor Market," *Industrial and Labor Relations Review* 56, pp.84-96.
Kwon, H. (2015), "Quality of the Labor Market and Employment Legislation," in: Statistical Research Institute , eds., *Korean Social Trends 2015*, Seoul, Statistical Research Institute, pp.153-162.
Lagakos, D., B. Moll, T. Porzio, N. Qian and T. Schoellman (2018), "Life Cycle Wage Growth across Countries," *Journal of Political Economy* 126, pp.797-849.
Nakamura, E. (2008), "Layoffs and Lemons over the Business Cycle," *Economics Letters* 99, pp.55-58.
Robinson, P.M. (1988), "Root-N-Consistent Semiparametric Regression," *Econometrica* 56(4), pp.931-954.
Rosenbaum, P.R. and D.B. Rubin (1983), "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika* 70, pp.41-55.
Song, Y. (2007), "Recall Bias in the Displaced Workers Survey: Are Layoffs Really Lemmons?" *Labour Economics* 12, pp.335-345.
Wooldridge, J.M. (2015), *Introductory Econometrics: A Modern Approach*, Boston, Cengage Learning.