Relationships between Elderly Employment and Labor Market Outcomes of Young and Prime-Age Adults:

Evidence from Korean Longitudinal and Cross-Sectional Data

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Abstract

Along with an increase in the aging population, the elderly poverty rate is on the rise in Korea. As older people extend working years and delay retirement to secure their financial stability, it raises a concern that an increase in elderly employment may cause high unemployment among the youth. To understand the relationship between elderly employment and labor market outcomes of other age groups, we use the 1998-2017 Korea Labor and Income Panel Study and then the 1990, 1995, 2000 and 2005 Korean Population Census for robustness checks. Using a logistic regression model, we find that elderly employment has no relationship with youth employment but has a statistically significant relationship with prime-age employment that varies by gender. While prime-age men are likely to substitute for older men, prime-age women are likely to complement both older men and older women. Similar results hold with respect to unemployment, hours of work, and weekly wages. These relationships are more pronounced between older adults and prime-age adults of the same gender and with the same level of education. The strongest substitutability is found between older male workers and prime-age male workers for low-skilled jobs and between older female workers and older male workers for high-skilled jobs. Regardless of skill level, both older male and female workers are likely to complement young and prime-age female workers. Although the magnitude may vary by industry sector, the largest gender difference is found between the employment of prime-age and older adults in the sales and service sectors. While it confirms no substitution effect between elderly employment and youth employment, overall results lead to further research on employment policies for young and older people and factors that attribute to high youth unemployment in Korea.

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Delayed Retirement

Elderly Employment

Youth Employment

Lump-of-Labor Theory

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JEL Category Selection:

J14, J16, J21

1. Introduction

A high life expectancy and better health allow older people to continue to work even in their retirement years. In particular, high-income countries experience a gradual increase in the labor force participation rate among older people since 2000 (IMF, 2018). However, at the same time, youth unemployment is high in many developed countries (United Nations, 2016). The global youth unemployment rate is around 13 percent (World Bank, 2019). Due to informal, part-time, and temporary jobs with low wages, youth are likely to be at risk of poverty even if they are employed (Hwang, 2014).

According to the “lump of labor” theory, the amount of work is assumed to be limited. Although it is widely acknowledged as a fallacy, people have been concerned that an increase in elderly employment may reduce job opportunities for the youth. A number of international studies have investigated the claim of whether older people’s extended working years or delayed retirement affect youth labor market outcomes. Many studies have shown that there is no substitution effect but some complementary effect of elderly employment on youth labor market outcomes mostly in the context of OECD countries (Gruber & Milligan, 2010; Kalwij et al., 2009; Kondo, 2016; Munnel & Wu, 2012; Oshio et al, 2012; Zhang & Zhao, 2012). Yet, a few studies argue marginal substitutability between older workers and young workers (Vestad, 2012; Martins et al, 2009). Mixed results that vary by country even among OECD countries motivate us to explore the relationship between elderly employment and labor market outcomes of young and prime-age workers in Korea, the country with a high elderly poverty rate and a high youth unemployment rate.

Korea, as one of the fastest aging countries, experiences various socioeconomic problems related to aging. While the average life expectancy continues to rise, the elderly poverty rate is high as 47.2 percent (Statistics Korea, 2018a). Limited pension benefits lead older people to postpone their retirement and stay longer in the labor market. A generous public pension may increase the financial security of older people, however, it may impose heavier socioeconomic burdens on the youth especially given that the youth unemployment rate remains high at 9.5 percent (Statistics Korea, 2018b). A significant proportion of youth stays economically inactive while preparing for civil service examinations or taking vocational training. Its proportion is the highest among those aged 25 to 29 (Hwang, 2014). Because of the high youth unemployment rate and limited evidence describing the relationship between elderly employment and youth employment, the Korean government has been hesitant to create more work opportunities for older people. Despite an increased need for a better understanding of the Korean labor market along with demographic changes and increased public attention to the labor market relationship between older workers and young workers, this issue has attracted little empirical interest. Several Korean studies have argued that industry sectors and occupations in which young workers are crowded are different from those in which older workers are crowded and thus no substitution effect between young and older workers (An, 2011; Keum, 2007; D. Kim, 2004; 2010; J. Y. Kim 2011; Kwon 2010; Lee, 2016; Shin 2009). However, the majority of existing empirical studies have compared elderly employment to youth employment at the aggregate level or focused on particular industry sectors. The impact of an aging labor force on worker dynamics has not been estimated at the individual level. Given that no cohesive answer has as yet emerged to answer the question of whether older workers crowd out young workers from the labor market in Korea, the individual-level analysis on the effect of elderly employment on youth employment may allow us to provide insightful results with the consideration of individual demographic and socioeconomic characteristics.

We aim to examine the relationship between elderly employment and labor market outcomes of young and prime-age workers in terms of employment, unemployment, hours of work, and weekly wages. This study contributes to the understanding of the Korean labor market in the context of crowding-out hypothesis by broadening the analysis to the individual-level and segregating the effect by gender, educational attainment, skill level, and industry sector using both Korean panel data and population census data.

Section 2 provides a literature review on the relationship between older people's labor force participation decisions and young worker's labor market outcomes. Section 3 describes the analytical framework and details the empirical specification. Section 4 illustrates the data. Sections 5 and 6 present the results and robustness checks. Section 7 discusses conclusions and further research.

2. Literature review

There is a large body of international literature examining the relationship between elderly employment and youth employment. Several studies have analyzed the relationship between the labor supply of older workers and young workers and estimated the magnitude of the crowding-out effect using cross-sectional data. Gruber and Milligan (2010) used the 1962-2007 U.S. Current Population Survey (CPS) to examine the impact of elderly employment and early retirement incentives on the employment of young and prime-age workers. Due to a substantial increase in female labor force participation over the study period, which stood in contrast to high and stable labor force participation among men, the study focused only on men's labor supply. Older men's employment rates were positively associated with the employment rates of young and prime-age male workers. Early retirement incentives had no impact on the employment of young and prime-age men. Furthermore, Munnel and Wu (2012) measured the effect of delayed retirement on youth unemployment using the 1977-2011 CPS. The results showed that an increase in elderly employment does not reduce young workers' job opportunities or wages regardless of gender and confirmed no crowding-out effect of elderly employment on youth labor market outcomes.

While several studies focused on the U.S. labor market, other studies extended their interest to Asian labor markets. Munnel and Wu (2012) found no relationship between the employment rates of older people and the unemployment rates of young and prime-age people using the 1990-2005 China Population Census (CPC). Only a statistically significant positive relationship they found was between older workers with low educational backgrounds and young workers with low educational backgrounds. Using the population data of 1990, 2000, and 2005 China micro-census, Zhang and Zhao (2012) found that elderly employment is positively associated with young workers' labor force participation rates and wages in China. Oshio et al. (2012) used the 1965-2007 Japanese Labor Force Survey to measure the impact of the social security reform and employment policy changes, which raised the eligibility age for the full pension payment and the level of benefits, on youth employment. Policy changes that promoted the labor force participation of older people were positively associated with youth employment although it was not statistically significant. Early retirement had no impact on the labor market outcomes of young workers. These results suggested that changes in social security or employment policies may affect older people's labor force participation decisions but not determine youth unemployment.

While a number of studies investigated the relationship between elderly employment and youth labor market outcomes using cross-sectional data, there were some studies that examined the substitution effect between young and older workers using panel data. Kalwij et al (2009) tested whether older workers can substitute for young and/or prime-age workers using data of 22 OECD countries followed over the time period 1960-2008. The results showed no substitution relationship between young and older workers but a complementary relationship between prime-age and older workers. Ji (2012) also found similar results that older workers do not compete with young workers especially for low-wage jobs using the 1990-2010 OECD panel data. Kondo (2016) examined the impact of the pension reform, which promoted the employment of older workers by raising the minimum age to receive full pension benefits, on employment decisions and earnings of older people and labor force participation of young people using the 2002-2011 Japanese Employment Trend Survey data. While older women's earnings and part-time job opportunities declined due to the pension reform, no statistically significant relationship was found between young full-time workers and older workers.

Unlike the large body of studies presenting no relationship between elderly employment and youth labor market outcomes, a few studies suggested some negative associations between young and older workers.

Vestand (2013) found that early retirement increases job opportunities for young people in the Norwegian labor market. Martins et al. (2009) examined the impact of an increase in the retirement age on the demand for workers of different ages in Portugal. The results indicated that the demand for young workers is likely to decrease as older workers stay longer in the workforce. Young women were particularly affected the most by that public pension reform. Bertoni and Brunello (2017) focused on the effect of the pension reform, which made workers aged 50 and older ineligible to retire by raising the minimum retirement age, on youth and prime-age employment. The study found a statistically significant substitution relationship between elderly employment and youth employment.

Existing studies provide mixed results on the substitutability between young workers and older workers that vary by country. Despite the fact that Korea experiences dynamic demographic transitions that may drive even more rapid changes in the labor market, there has been a limited number of studies on the relationship between young, prime-age, and older workers and their substitutability in the workforce. Similar to existing international literature, several Korean studies found that older workers are not substitutable for young workers (Ahn, 2011; D. I. Kim, 2004; J. Y. Kim, 2011) and particularly in the service and manufacturing sectors (Lee et al., 2015; Shin, 2009). Furthermore, some studies showed no association between industry sectors with high youth employment rates and those with high elderly employment rates (Keum, 2007; Kwon, 2010) to support the argument. The types of occupations that young people prefer to take were appeared to be different from what older people are likely to take. For instance, young workers were more likely to be concentrated in knowledge-based service jobs whereas older workers were concentrated in low-level service jobs (Lee et al., 2015). Young and unskilled workers were less likely to substitute for skilled workers in prime-age or in old age (Shin, 2009).

So far, the majority of studies have measured the relationship between elderly employment and youth employment at the country-, province-, or state-level. The aggregate analysis provides a good illustration of how elderly employment rates can be related to labor market outcomes of young and prime-age workers. Nonetheless, the aggregate analysis makes it difficult to estimate the impact of demographic changes on individuals in the labor market and measure the magnitude of individual variations. Examining the relationship between elderly employment and labor market outcomes of young and prime-age adults at the individual level and by demographic and socioeconomic factors may permit this study to point out some aspects which might not have been found through the aggregate analysis.

3. Methodology and Data

3.1 Theoretical framework

Consider a logistic regression that estimates the probability of an outcome occurring. It can be used to model the relationship between a binary dependent variable and a set of independent variables that are assumed to have direct effects on the dependent variable. The logistic regression model can be specified as following (Woodridge, 2010):

$$\log\left(\frac{\pi(Y=1|X)}{1-\pi(Y=1|X)}\right) = X'\beta \tag{1}$$

where Y is a binary dependent variable, X is a vector of explanatory variables, and β is a regression coefficient. By rewriting Equation (1) as:

$$\frac{\pi(Y=1|X)}{1-\pi(Y=1|X)} = e^{X'\beta} \tag{2}$$

Equation (2) provides the odds ratio in favor of the occurrence of the dependent variable. The probability of occurrence can be predicted by the following logistic function:

$$\pi(Y=1|X) = \frac{1}{1+e^{X'\beta}} \tag{3}$$

which converts the predicted value from log odds to probability.

3.2 Empirical specification

This study uses the logistic regression model to examine the relationship between elderly employment and labor market outcomes of youth and prime-age adults. The following equation specifies the logistic regression model of the form:

$$\text{Logit}\, P(Y_{iwt} = 1 |\, OldEmp_{wt}, X_{iwt}) = \beta_0 + \beta_1 OldEmp_{wt} + \beta_2 X_{iwt} + \gamma_w + \delta_t + \varepsilon_{iwt} \quad (4)$$

where Y_{iwt} indicates the labor market outcome of individual i in ward w at year t. Wards(*gu*) refers to the wards of the capital city[5], six megacities[6], and other small cities[7]. OldEmp_{wt} is the average employment rate of older people aged 55 to 64 in ward w at year t. X_{iwt} is a vector of time-varying explanatory variables measured at the individual-level or ward-level at year t. γ_w represents a set of ward controls. δ_t is an indicator variable for the years 1998 – 2017. ε_{iwt} is an idiosyncratic error term. β_1, as the coefficient of interest, represents the likelihood of being employed for young, prime-age, and older adults as the ward average elderly employment rate changes.

4. Data and measures

4.1 Data

Korea Labor and Income Panel Study (KLIPS) is a longitudinal survey that focuses on the economic and labor market activities of individuals in urban areas. It provides detailed information on income and consumption, education, labor force participation, job mobility, job training, working conditions, welfare, unemployment, and retirement. The KLIPS survey started with 5,000 households and 13,321 individuals aged 15 and over. It has been conducted for over two decades since 1998. We use KLIPS to investigate whether the rapid demographic transitions have driven changes in the labor market outcomes of young, prime-age, and older men and women and if so, examine their relationship in the labor market. The main analysis uses a sample of 177,959 individuals aged 20 to 64 in urban areas.[8]

To check the consistency of the results, we use the Korean Population Census (KPC) data. It is conducted every five years since 1970. As a cross-sectional survey, KPC takes approximately 2 percent of the total population as a sample. It provides the complete geographic coverage of Korea. Similar to KLIPS but with a larger sample, it collects data on various socioeconomic and demographic attributes including economic activities, birth history, migration, aging, housing, and welfare. For the robustness check, we take a sample of about 500,000 people aged 20 to 64 in urban areas from the KPC data for years 1990, 1995, 2000, and 2005. Note that hours of work and wages are only available in the KLIPS data, not in the KPC data.

4.2 Measures

Elderly employment rate

KLIPS has annually conducted the survey since 1998. During the study period, some wards were aggregated(segregated) to larger(smaller) administrative areas or changed their names. For consistency, we use 243 wards that existed in 1998. The elderly employment rate is computed based on the employment status of older people aged 55 to 64 in each ward in a given year for each gender.

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[5] Seoul, as the capital city of Korea, has a population of 11 million people.
[6] Megacities (*Gwang-yeok-si*) are metropolitan cities with a population of over 1 million people.
[7] Small cities (*si*) have a population of more than 50,000 but less than 1 million people.
[8] KLIPS includes households and individuals in rural areas. However, these rural residents are the ones who originally lived in urban areas and moved to rural areas. Since they may not represent typical characteristics of rural residents, we exclude residents in rural areas from the sample.

Labor market outcomes

KLIPS checks the employment status of all respondents aged 15 and over and collects additional information on hours of work and wages for those in the workforce. The labor market outcomes include employment status, unemployment status, hours of work, and wage rate. Employment status is a binary variable that takes a value of 1 if an individual is employed as a regular, temporary, daily, non-paid family-business worker, an employer, or a self-employed and 0 if an individual is unemployed or not in the labor force. Unemployment status is a binary variable that takes a value of 1 if an individual has actively looked for a job in the past four weeks and 0 otherwise. Log-transformed weekly hours of work and wages are used as labor market outcome variables in addition to employment and unemployment status. To explore heterogeneity in the labor market outcomes at a different stage of life, we stratify the sample by three age groups: young (age 20 to 24), prime-age (age 25 to 54), and old (age 55 to 64). As men and women may take different career paths as having different life courses (Oesterle et al., 2010), the sample is further stratified by gender. All the labor market outcomes are separately measured for young, prime-age, and older men and women. To check the endogeneity of the regression results, we use the ward-level share of older men who do not have any difficulties in their daily activities[9] as an instrumental variable for the ward-level elderly employment rate.

Explanatory variables

Individual-level variables include age and age square and average years of schooling. Ward-level variables include the shares of high school graduates or less, students, population, self-employed, manufacturing employment, and service employment and the ward average housing price per 3.3 square meters. These ward-level variables are measured for each year and for each age and gender group using KLIPS data. As an additional control variable that reflects each ward's economic status, average weekly wages are measured by age group regardless of gender. Ward population, GRDP per capita, and GRDP growth rates are retrieved from the Statistics Korea Index (Statistics Korea, 2019). Annual GRDP per capita and GRDP growth rate are measured at the ward level regardless of gender and age group.

5. Results

5.1 Descriptive statistics

To understand demographic changes over two decades, Tables 1 and 2 present the descriptive statistics for men and women by age group in 1998 and 2017 respectively.

Over 20 years, prime-age and older adults have shown a substantial increase in the years of schooling. For men, the mean years of schooling have increased on average by 2 years. Prime-age and older men's average years of schooling increased from 12.23 years to 14.25 years and from 9.47 years to 11.72 years respectively. For women, the mean years of schooling have increased on average by 3 to 4 years. Prime-age and older women's average years of schooling increased from 10.95 years to 13.83 years and from 6.30 years to 10.35 years respectively. Regarding young men and young women, the comparison of their average years of schooling between 1998 and 2017 does not provide insightful information as a considerable proportion of young adults became more likely to stay in school at the age of 20 to 24.

The share of high school graduates or less has declined for both men and women. For instance, the share of prime-age adults with high school diplomas or less decreased from 65.1 percent to 31.3 percent for men and from 79.8 percent to 39.8 percent for women.

[9] Information on older men's activities of daily living is available in the 2005 and 2010 KPC data.

Table 1. Descriptive statistics for men by age group

	1998						2017					
	20- 24		25 - 54		55 - 64		20- 24		25 - 54		55 - 64	
	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
Individual-level variables												
Age	22.310	(1.465)	38.400	(8.219)	59.073	(2.790)	22.209	(1.495)	40.456	(7.966)	59.225	(2.806)
Years of schooling	13.439	(1.792)	12.234	(3.164)	9.468	(3.963)	13.998	(1.409)	14.252	(2.258)	11.723	(3.222)
Ward-level variables												
Share of students	0.402	(0.491)	0.039	(0.193)	0.000	(0.000)	0.459	(0.499)	0.024	(0.152)	0.001	(0.031)
Share of high school graduates or less	0.380	(0.486)	0.651	(0.477)	0.838	(0.369)	0.178	(0.383)	0.313	(0.464)	0.718	(0.450)
Share of self-employed	0.018	(0.134)	0.257	(0.437)	0.284	(0.451)	0.003	(0.056)	0.177	(0.382)	0.311	(0.463)
Share of service employment	0.024	(0.155)	0.037	(0.188)	0.033	(0.178)	0.041	(0.198)	0.042	(0.200)	0.036	(0.186)
Share of manufacturing employment	0.076	(0.264)	0.155	(0.362)	0.059	(0.236)	0.050	(0.218)	0.172	(0.377)	0.126	(0.332)
Average housing price	299.364	(268.764)	290.265	(465.623)	342.527	(487.727)	661.646	(456.490)	676.542	(476.658)	689.660	(526.174)
Average weekly wage	18.248	(3.767)	31.881	(5.568)	25.240	(12.573)	42.308	(27.747)	74.328	(11.294)	63.817	(17.701)
Log GRDP per capita	2.536	(0.639)	2.523	(0.679)	2.499	(0.681)	3.261	(0.571)	3.243	(0.565)	3.244	(0.611)
GRDP growth rate	-0.093	(0.084)	-0.083	(0.069)	-0.083	(0.064)	0.039	(0.045)	0.039	(0.046)	0.038	(0.051)
Share of population	0.044	(0.007)	0.243	(0.015)	0.038	(0.010)	0.036	(0.004)	0.235	(0.017)	0.074	(0.010)
Outcomes of interest												
Employed	0.251	(0.434)	0.794	(0.404)	0.602	(0.490)	0.216	(0.412)	0.887	(0.317)	0.818	(0.386)
Unemployed	0.159	(0.366)	0.104	(0.305)	0.109	(0.312)	0.025	(0.156)	0.020	(0.139)	0.007	(0.083)
Average hours of work per week	51.626	(14.502)	53.887	(17.822)	57.501	(23.740)	40.029	(13.073)	44.769	(10.106)	46.324	(13.546)
Average weekly wage	19.162	(7.223)	36.621	(24.871)	28.039	(20.899)	45.563	(65.946)	88.176	(52.187)	75.806	(54.873)
Observations	490		3,857		641		320		3,272		1,008	

Source: Authors' calculations using the 1998 and 2017 KLIPS.

Note: These are men aged 20 – 64 who completed the KLIPS survey in 1998 and 2017. Housing price per 3.3 square meters is in KRW 10,000. The average weekly wage is in KRW 10,000. The base year for real GRDP per capita and real GRDP growth rate is 2010.

Table 2. Descriptive statistics by age group for women

	1998						2017					
	20- 24		25 - 54		55 - 64		20- 24		25 - 54		55 - 64	
	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
Individual-level variables												
Age	21.967	(1.441)	38.096	(8.066)	59.314	(2.697)	22.042	(1.421)	40.545	(8.035)	59.276	(2.763)
Years of schooling	13.613	(1.568)	10.945	(3.280)	6.299	(3.246)	14.193	(1.317)	13.833	(2.224)	10.349	(3.078)
Ward-level variables												
Share of students	0.365	(0.482)	0.013	(0.112)	0.001	(0.037)	0.458	(0.499)	0.011	(0.104)	0.003	(0.053)
Share of high school graduates or less	0.371	(0.483)	0.798	(0.402)	0.968	(0.176)	0.165	(0.372)	0.398	(0.489)	0.879	(0.326)
Share of self-employed	0.010	(0.100)	0.104	(0.305)	0.115	(0.319)	0.000	(0.000)	0.079	(0.270)	0.119	(0.324)
Share of service employment	0.027	(0.163)	0.091	(0.287)	0.050	(0.219)	0.047	(0.213)	0.092	(0.289)	0.171	(0.376)
Share of manufacturing employment	0.080	(0.272)	0.079	(0.269)	0.015	(0.123)	0.022	(0.148)	0.062	(0.242)	0.077	(0.266)
Average housing price	287.696	(281.392)	296.885	(483.834)	317.428	(455.404)	658.564	(483.122)	705.691	(498.348)	699.107	(564.522)
Average weekly wage	18.321	(3.422)	32.027	(5.714)	23.677	(11.610)	39.070	(22.452)	74.453	(11.438)	62.367	(17.707)
Log GRDP per capita	2.501	(0.674)	2.517	(0.684)	2.526	(0.696)	3.220	(0.557)	3.238	(0.572)	3.232	(0.603)
GRDP growth rate	-0.087	(0.070)	-0.082	(0.067)	-0.085	(0.069)	0.038	(0.040)	0.040	(0.047)	0.035	(0.047)
Share of population	0.043	(0.006)	0.234	(0.017)	0.041	(0.013)	0.032	(0.005)	0.223	(0.024)	0.075	(0.011)
Outcomes of interest												
Employed	0.398	(0.490)	0.451	(0.498)	0.335	(0.472)	0.335	(0.473)	0.609	(0.488)	0.542	(0.498)
Unemployed	0.142	(0.350)	0.081	(0.273)	0.049	(0.216)	0.039	(0.194)	0.014	(0.117)	0.004	(0.061)
Average hours of work per week	46.532	(11.581)	53.270	(21.733)	56.974	(24.841)	39.025	(11.462)	40.619	(10.902)	44.264	(14.719)
Average weekly wage	18.067	(5.773)	21.582	(13.969)	15.260	(13.834)	36.962	(14.615)	52.851	(31.675)	42.563	(28.162)
Observations	696		3,806		716		358		3,225		1,067	

Source: Authors' calculations using the 1998 and 2017 KLIPS.

Note: These are women aged 20 – 64 who completed the KLIPS survey in 1998 and 2017. The average housing price per 3.3 square meters is in KRW 10,000. The average weekly wage is in KRW 10,000. The base year for real GRDP per capita and real GRDP growth rate is 2010.

The share of self-employed shows a time tend that varies by age group. For men, the share of self-employed declined from 1.8 percent to 0.3 percent among young workers and from 25.7 percent to 17.7 percent among prime-age workers while its share increased from 28.4 percent to 31.1 percent among older workers. Women's self-employed share shows a similar pattern to that of men but only with a modest increase. For women, the share of self-employed decreased from 1 percent to 0 percent among young workers and from 10.4 percent to 7.9 percent among prime-age workers whilst its share increased from 11.5 percent to 11.9 percent among older workers.

All the age and gender groups show an increase in the share of service employment but the rate of increase significantly varies by gender among older workers than among young and prime-age workers. From 1998 to 2017, the share of older male workers in the service sector has only increased from 3.3 percent to 3.6 percent while the shares have increased from 2.4 percent to 4.1 percent and from 3.7 percent to 4.2 percent for young and prime-age male workers respectively. As for female workers, the share of older female workers has tripled from 5 percent to 17.1 percent whereas young and prime-age female workers show a relatively small increase in the share of service employment: from 2.7 percent to 4.7 percent for young female workers and from 9.1 percent to 9.2 percent for prime-age female workers respectively. It should be further noted that the service sectors in which young adults are likely to work may be different from those in which older adults are employed even if they are all employed in service occupations as Lee et al. (2015) have found.

Young people became less likely to work in the manufacturing industry, and thus, the share of manufacturing employment has declined among young and prime-age workers: from 7.6 percent to 5.0 percent among young male workers, from 8.0 percent to 2.2 percent among young female workers, from 15.5 percent to 17.2 percent among prime-age male workers, and from 7.9 percent to 6.2 percent among prime-age female workers. In contrast, older people's labor supply in the manufacturing sector has increased regardless of gender. The share of manufacturing employment more than doubled from 5.9 percent to 12.6 percent among older male workers and more than quintupled from 1.5 percent to 7.7 percent among older female workers. Changes in the share of self-employed, service employment, and manufacturing employment suggest that the sectors and occupations in which young adults are likely to be crowded may not be the same as those in which older adults are crowded.

The gross regional domestic product (GRDP) per capita[10] has doubled on average from KRW 12,391,000 to KRW 25,525,000. The GRDP growth rate has significantly increased from a negative rate in 1998 to a positive 4 percent in 2017. Note that Korea experienced the Asian financial crisis in the year 1997-1998. Although Korea has slowly recovered from negative economic growth, its rate remains at 4 percent which is lower than 6 percent that had lasted for the past four decades in Korea.

Changes in the proportion of each age and gender group from 1998 to 2017 reflect demographic changes that Korea experiences. For instance, the proportion of young and prime-age adults in the male population decreased from 4.4 percent to 3.6 percent and from 24.3 percent to 23.5 percent respectively. The proportion of older adults in the male population almost doubled from 3.8 percent to 7.4 percent.

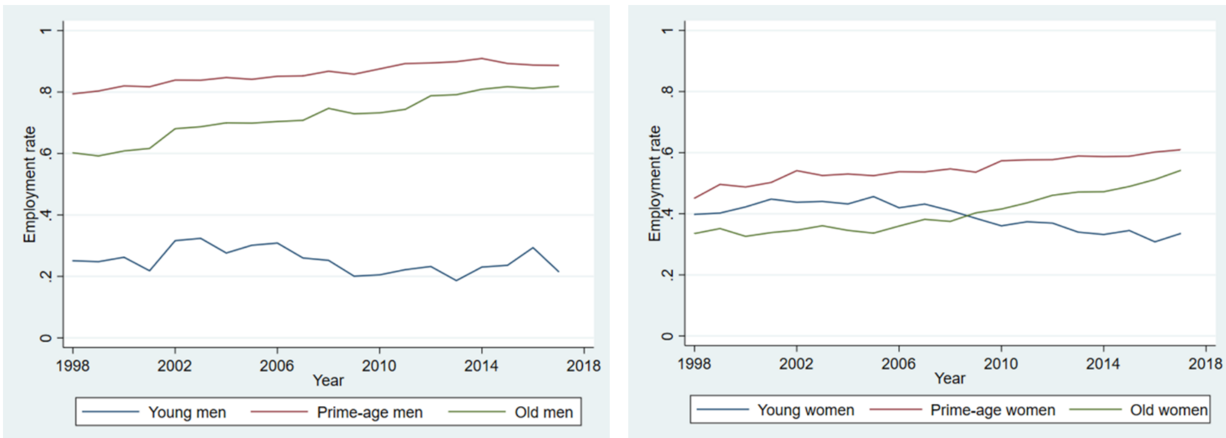
While the youth employment rate shows a downward trend for both genders, declining from 25.1 percent to 21.6 percent for men and from 39.8 percent to 33.5 percent for women, the employment rates for prime-age and older adults show upward patterns. For men, the employment rate has increased from 79.4 percent to 88.7 percent for prime-age adults and from 60.2 percent to 81.8 percent for older adults. For women, the employment rate has increased rapidly from 45.1 percent to 60.9 percent for prime-age adults and from 33.5 percent to 54.2 percent for older adults. It should be noted that all able-bodied young men must serve mandatory military service around the age of 20 in Korea. It partially explains the lower

[10] The GRDP data for many wards in small- and medium-size cities was not available for years before 2008. We computed the GRDP for these wards using the GRDP reported at the mega-city or province-level in year 2008 and beyond and the share of wards in the capital, megacities, or provinces where each ward belonged in a given year.

employment rate of young men compared to that of young women. Furthermore, an increase in the share of students for both genders might have contributed to the decrease in youth employment.

Figure 1 shows the trend of employment for youth, prime-age, and older men and women over the period of 1998 to 2017. As found from the descriptive statistics in Tables 1 and 2, the youth employment rate slowly declines while the prime-age employment rate continues to rise. The elderly employment rate increases even faster than that of prime-age. The elderly employment rate shows an increasing trend regardless of gender; however, the rise is faster among older women than among older men.

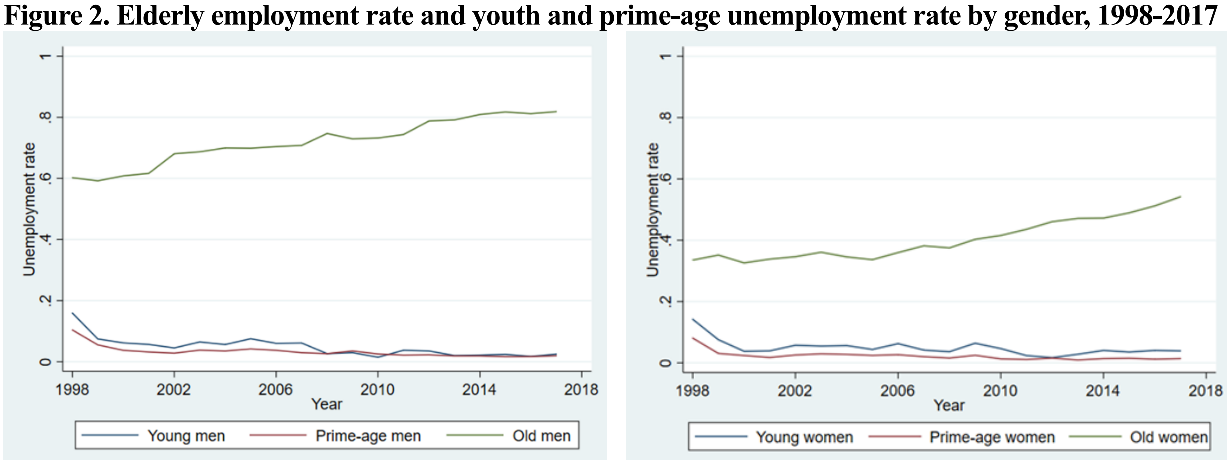
Figure 1. Employment rates by age group and gender, 1998-2017



Source: Authors' calculations using KLIPS, 1998 - 2017.

Figure 2 shows the trend of youth and prime-age unemployment and elderly employment for men and women over the period of 1998-2017. As opposed to a steady increase in elderly employment, the youth unemployment rate significantly decreases for both men and women. Despite the decrease, the youth unemployment rate remains at around 10 percent since 2000 which is higher than the prime-age unemployment rate.

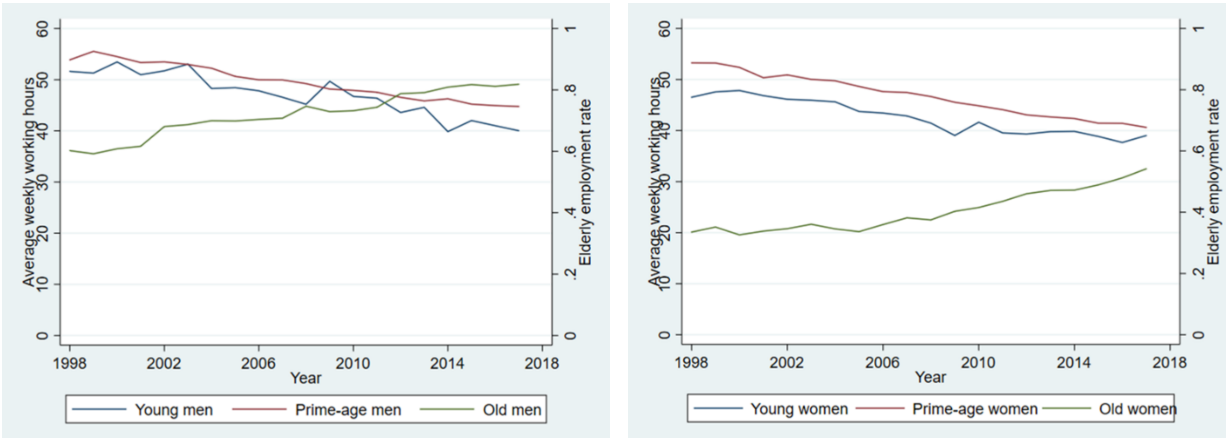
Figure 2. Elderly employment rate and youth and prime-age unemployment rate by gender, 1998-2017



Source: Authors' calculations using KLIPS, 1998 - 2017.

Figure 3 shows the trend of working hours among youth and prime-age workers compared with elderly employment for both genders from 1998 to 2017. Although the average hours of work decline for young and prime-age adults while the elderly employment rates incline, we do not find any supporting evidence on the relationship between the working hours of young and prime-age workers and the employment rate of older workers. The reduction in the average hours of work for young and prime-age workers may be due to the slow economy and the legislation that the Korean government implemented to limit the maximum working hours.

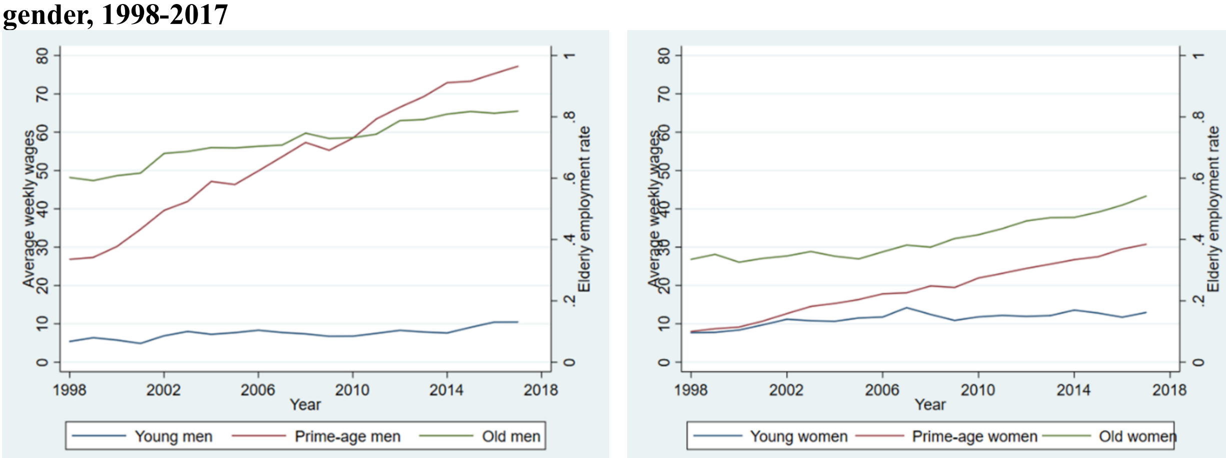
Figure 3. Elderly employment rate and average work hours of young and prime-age adults by gender, 1998-2017



Source: Authors' calculations using KLIPS, 1998 - 2017.

Figure 4 shows the trend of weekly wages among youth and prime-age workers compared with elderly employment for men and women from 1998 to 2017. The average weekly wage increases from KRW 216,450 to KRW 425,990 across age groups while the elderly employment rate gradually rises, however, it is not apparent whether the average weekly wages of young and prime-age workers are associated with the changes in elderly employment for both genders.

Figure 4. Elderly employment rate and average weekly wages of young and prime-age adults by gender, 1998-2017



Source: Authors' calculations using KLIPS, 1998 - 2017.
Note: The average weekly wage is in KRW 10,000.

5.2 Regression Result using Individual Data from 1998-2017 Korea Labor and Income Panel Study

Table 3 shows the results of the logistic regression analysis on the relationship between youth and prime-age employment and elderly employment. While elderly employment has no relationship with the employment status of young adults regardless of gender (Table 3, Column 1, 3, 6, 9), it has a statistically significant relationship with the employment status of prime-age adults that run in opposite directions by gender.

With respect to the employment rate of older men, it is negatively associated with the employment status of prime-age men. One percent increase in the employment rate of older men decreases the odds of being employed for prime-age men by 1.3 percent although it is marginally significant ($p<0.1$, Table 3, Column 2). Older women's employment is positively associated with the employment status of prime-age men. One percent increase in the employment rate of older men raises the odds of being employed for prime-age women by 2.2 percent ($p<0.01$, Table 3, Columns 4). We find no statistically significant relationship between the employment rate of older men and the employment status of young men, young women, and older women (Table 3, Columns 1, 3, and 5). These results suggest that older male workers are substitutable with prime-age male workers while they complement prime-age female workers.

Labor market choices and decisions made by women could be different from those made by men due to various socioeconomic factors and cultural norms. It is important to examine the substitutability of older female workers with others in different age and gender groups. With respect to older women's employment rate, we find a statistically significant positive relationship with the employment status of prime-age women. As the elderly employment rate for older women increases by 1 percent, the odds of being employed for prime-age women also increases by 2.6 percent ($p<0.01$, Table 3, Column 10), suggesting the complementary relationship between older female workers and prime-age female workers. No relationship is found between the employment rate of older women and the employment status of young men, young women, prime-age men, and older men (Table 3, Columns 6, 7, 8, and 9).

As discussed earlier, the proportion of young adults in school has significantly increased over two decades. Most young men should complete compulsory military duty during their college years in Korea. Since a considerable proportion of young adults aged 20 to 24 are likely to be not in the labor force for various reasons including school and military service, several studies including Zhang (2012) excluded students from the sample. Since we use the individual-level data, we do not exclude those students aged 20 to 24. Instead, we include the share of students measured at the ward-level as an additional control variable. The employment of young adults aged 20 to 24 shows a negative correlation with their years of schooling measured at the individual level whereas it shows a positive correlation with the share of students, self-employment, service employment, and manufacturing employment measured at the ward-level. We find no statistically significant correlation between youth employment and the share of high school graduates or less which is an indicator of low education.

The real GRDP per capita has a statistically significant positive coefficient on youth employment for men and elderly employment for women. Although the coefficients for megacities and provinces are not reported in Table 3 due to limited space, they all have negative coefficients on the youth employment rate for men except two provinces[11] in which manufacturing and service jobs for young male workers are concentrated. It suggests that young male workers in most megacities and provinces are less likely to be employed compared to those in the capital. The year indicator variables show that the Asian financial crises in the year 1997-1998 led to a downturn in the Korean economy.

In addition to the employment status, we use the unemployment status, hours of work, and weekly wages to check the relationship between elderly employment and various labor market outcomes of young and prime-age adults. Table 4 shows no relationship between elderly employment and the unemployment status of young and prime-age adults regardless of gender (Table 4, Panel A, Columns 1, 2, 4, 5). These may imply that the increased employment rate of older adults does not affect the likelihood of being unemployed for other age and gender groups. However, we may need further investigation to ensure the statistical reliability of the unemployment status variable used for the main analysis before drawing a conclusion about the impact of elderly employment on youth and prime-age unemployment.

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[11] Gyeonggi province includes Seoul (capital), Incheon (megacity), and other small cities surrounding Seoul. As cities closed to the capital, manufacturing and service jobs are concentrated in Gyeonggi province. Jeju province is popular with tourists. Through a tourism boom since the 1990s, there has been a remarkable increase in service jobs in Jeju province.

Table 3. Relationship between elderly employment and employment status of young and prime-age people by gender

VARIABLES	(1) Young Male	(2) Prime-age Male	(3) Young Female	(4) Prime-age Female	(5) Old Female	(6) Young Male	(7) Prime-age Male	(8) Old Male	(9) Young Female	(10) Prime-age Female
Older men's employment	-0.010	-0.013*	0.002	0.022***	-0.018					
	(0.018)	(0.007)	(0.015)	(0.005)	(0.016)					
Older women's employment						0.024	-0.007	-0.021	0.011	0.026***
						(0.022)	(0.008)	(0.019)	(0.018)	(0.006)
Age	-2.545**	0.958***	2.881***	-0.047***	-0.118	-2.561**	0.959***	-0.429	2.887***	-0.049***
	(1.118)	(0.022)	(0.830)	(0.017)	(0.538)	(1.118)	(0.022)	(0.527)	(0.830)	(0.017)
Age square	0.068***	-0.011***	-0.050***	0.001***	-0.002	0.068***	-0.011***	0.000	-0.050***	0.001***
	(0.025)	(0.000)	(0.019)	(0.000)	(0.005)	(0.025)	(0.000)	(0.004)	(0.019)	(0.000)
Years of schooling	-0.485***	0.126***	-0.154***	-0.005	-0.220***	-0.485***	0.126***	0.003	-0.154***	-0.005
	(0.038)	(0.013)	(0.034)	(0.014)	(0.035)	(0.038)	(0.013)	(0.024)	(0.034)	(0.014)
Share of population	0.084	-0.001	0.065	0.009	-0.252***	0.095	0.003	0.023	0.067	0.008
	(0.119)	(0.022)	(0.106)	(0.013)	(0.078)	(0.119)	(0.022)	(0.076)	(0.106)	(0.013)
Share of students	-0.012***	-0.030***	-0.017***	0.008	0.035	-0.012***	-0.032***	-0.117***	-0.017***	0.010*
	(0.003)	(0.008)	(0.002)	(0.006)	(0.039)	(0.003)	(0.008)	(0.035)	(0.002)	(0.006)
Share of high school graduates or less	-0.001	-0.004	-0.009***	0.000	-0.013***	-0.001	-0.004	-0.003	-0.009***	0.000
	(0.003)	(0.002)	(0.003)	(0.002)	(0.005)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)
Average housing price	-0.000	-0.000	-0.000*	0.000	-0.000	-0.000	-0.000	-0.001***	-0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of self-employed	0.050***	0.016***	0.045***	0.027***	0.021***	0.051***	0.017***	0.046***	0.045***	0.027***
	(0.011)	(0.004)	(0.009)	(0.003)	(0.004)	(0.011)	(0.004)	(0.004)	(0.009)	(0.003)
Share of service employment	0.067***	0.018***	0.042***	0.057***	0.086***	0.066***	0.018***	0.010*	0.042***	0.057***
	(0.006)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)	(0.005)	(0.006)	(0.004)	(0.004)
Share of manufacturing employment	0.056***	0.028***	0.038***	0.013***	0.037***	0.056***	0.028***	0.040***	0.038***	0.013***
	(0.005)	(0.004)	(0.004)	(0.003)	(0.006)	(0.005)	(0.004)	(0.006)	(0.004)	(0.003)
Share of unemployed	-4.070**	-8.544***	-1.494	0.145	-2.124	-4.010**	-8.520***	-5.364***	-1.472	0.138
	(1.849)	(0.655)	(1.387)	(0.523)	(1.594)	(1.850)	(0.655)	(1.453)	(1.387)	(0.523)
Log GRDP per capita	-0.050	0.099**	0.062	0.024	-0.197	-0.052	0.099**	-0.005	0.059	0.020
	(0.091)	(0.042)	(0.078)	(0.036)	(0.132)	(0.091)	(0.042)	(0.114)	(0.078)	(0.036)
GRDP growth rate	1.458*	0.435	-0.485	-0.071	1.382**	1.490*	0.440	0.063	-0.488	-0.089
	(0.835)	(0.307)	(0.657)	(0.221)	(0.575)	(0.835)	(0.307)	(0.575)	(0.657)	(0.221)
Constant	27.684**	-18.679***	-37.058***	-1.145**	15.005	27.740**	-18.822***	25.567	-37.149***	-1.031*
	(12.367)	(0.751)	(9.155)	(0.559)	(15.992)	(12.367)	(0.747)	(15.713)	(9.157)	(0.557)
Region dummy	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Wald chi2	549.34	3446.67	858.03	1411.96	714.19	549.37	3445.96	805.58	857.89	1410.65
P-value	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Observations	6,256	65,142	8,575	64,896	15,777	6,256	65,142	14,836	8,575	64,896

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively. The share of the population refers to the share of each age and gender group listed on the top of the table. The ward average housing price per 3.3 square meters is measured in KRW 10,000. The base year for real GRDP per capita and real GRDP growth rate is 2010. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

Similar to the results with the employment status, elderly employment is not statistically associated with hours of work or weekly wages for young people regardless of gender. A 1-percent increase in the employment rate of older men reduces the likelihood of working longer hours and earning higher wages for prime-age men by 1.4 percent and 2 percent respectively (Table 4, Panels B and C, Column 2). Prime-age women are 1.8 percent more likely to work longer hours while their wages remain unchanged as the employment rate of older men rises by 1 percent (Table 4, Panels B and C, Column 5). With respect to older women's employment rate, it shows a positive relationship only with prime-age women's hours of work and weekly wages. A 1-percent increase in the employment rate of older women raises the likelihood for prime-age women to work longer hours and earn higher wages by 2.5 percent and 1.7 percent respectively (Table 4, Panels B and C, Column 5).

Table 4. Relationship between elderly employment and labor market outcomes of young and prime-age people by gender

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Young Male	Prime-age Male	Old Male	Young Female	Prime-age Female	Old Female
Panel A Dependent variable: Unemployment						
Older men's employment	0.001	0.009	.	0.007	-0.001	0.031
	(0.024)	(0.010)	(.)	(0.020)	(0.011)	(0.032)
Older women's employment	0.016	0.006	-0.033	0.001	0.013	.
	(0.030)	(0.011)	(0.027)	(0.024)	(0.013)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	6,256	65,142	14,836	8,575	64,896	15,777
Panel B Dependent variable: Log-transformed hours of work per week						
Older men's employment	-0.015	-0.014**	.	0.000	0.018***	-0.010
	(0.019)	(0.007)	(.)	(0.016)	(0.005)	(0.016)
Older women's employment	0.026	-0.002	-0.025	0.017	0.025***	.
	(0.023)	(0.008)	(0.019)	(0.019)	(0.006)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	6,256	65,142	14,836	8,575	64,896	15,777
Panel C Dependent variable: Log-transformed wages per week						
Older men's employment	-0.028	-0.020***	.	0.001	0.008	-0.010
	(0.019)	(0.006)	(.)	(0.016)	(0.005)	(0.016)
Older women's employment	0.018	-0.007	-0.008	0.015	0.017***	.
	(0.024)	(0.008)	(0.017)	(0.019)	(0.006)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	6,256	65,142	14,836	8,575	64,896	15,777

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively under each panel. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

One of the advantages of examining the association at the individual level is that we can conduct subgroup analyses after segregating the sample by demographic and socioeconomic factors. We stratify the sample by the level of education, skill level, and industry sectors to investigate the factors that affect the relationship between young, prime-age, and older workers in the labor market.

In Table 5, the level of education is classified as high school graduates or less and college graduates or higher. The elderly employment rate is paired with the employment status of young, prime-age, and older adults depending on their levels of education, creating four combinations for each age and gender group[12]. We find a statistically significant positive effect of elderly employment on the likelihood of being employed for young and prime-age adults if they had the same level of education for both genders (Table 5, Panel A and C, Columns 1, 2, 4, and 5). No statistically significant relationship is found between the employment rate of older men and the employment status of young and prime-age men if their levels of education were different (Table 5, Panel C, Columns 1 and 2). In contrast, an increase in the employment rate of old men with high levels of education is likely to decrease the likelihood of being employed for both young and prime-age women regardless of their educational levels (Table 5, Panel B and D, Columns 4 and 5). While an increase in the employment rate of older women does not change the likelihood of being employed for young and prime-age men regardless of their educational level, it raises the likelihood of being employed for young and prime-age women if their levels of education were the same (Table 5, Panel A and D, Columns 4 and 5). In addition, along with an increase in the employment rate of older women with low levels of education, older men with high levels of education are more likely to be employed (Table 5, Panel C, Column 3) whereas the opposite doesn't hold.

These results suggest that older workers can be complementary to young and prime-age workers if their levels of education were the same for both men and women. Moreover, older female workers with low levels of education can be complementary to older male workers with high levels of education while older male workers with high levels of education can be substitutable with young and prime-age female workers disregarding their levels of education.

Table 5. Relationship between elderly employment and employment status of young and prime-age people, by educational level

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Young Male	Prime-age Male	Old Male	Young Female	Prime-age Female	Old Female
Panel A: Young and prime-age adults with high school diplomas or less vs. older adults with high school diplomas or less						
Older men's employment	0.106***	0.203***	.	-0.003	0.003	-0.014
	(0.023)	(0.009)	(.)	(0.020)	(0.004)	(0.011)
Older women's employment	0.020	-0.007	0.002	0.096***	0.149***	.
	(0.026)	(0.007)	(0.011)	(0.022)	(0.005)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	1,481	31,609	11,805	1,654	39,480	14,489
Panel B: Young and prime-age adults with high school diplomas or less vs. older adults with college degrees or higher						
Older men's employment	0.001	0.006	.	-0.049**	-0.020***	-0.006
	(0.027)	(0.007)	(.)	(0.024)	(0.005)	(0.011)

[12] Panel A matches older adults with low levels of education to young and prime-age adults with low levels of education; Panel B matches older adults with low levels of education to young and prime-age adults with high levels of education; Panel C matches older adults with high levels of education to young and prime-age adults with low levels of education; Panel D matches older adults with high levels of education to young and prime-age adults with high levels of education for both genders.

Older women's employment	-0.033	0.000	-0.003	-0.009	-0.002	.
	(0.034)	(0.009)	(0.014)	(0.032)	(0.006)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	1,481	31,609	11,805	1,654	39,480	14,489
Panel C: Young and prime-age adults with college degrees or higher vs. older adults with high school diplomas or less						
Older men's employment	0.003	0.008	.	0.016	-0.004	-0.014
	(0.012)	(0.007)	(.)	(0.010)	(0.006)	(0.066)
Older women's employment	0.009	-0.000	0.074**	0.012	-0.004	.
	(0.013)	(0.007)	(0.030)	(0.011)	(0.006)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	3,805	33,527	2,652	5,565	25,416	990
Panel D: Young and prime-age adults with college degrees or higher vs. older adults with college degrees or higher						
Older men's employment	0.085***	0.324***	.	-0.019*	-0.018***	0.011
	(0.013)	(0.012)	(.)	(0.011)	(0.006)	(0.065)
Older women's employment	-0.021	0.002	-0.018	0.155***	0.261***	.
	(0.016)	(0.008)	(0.029)	(0.015)	(0.009)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	3,805	33,527	2,652	5,565	25,416	990

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively under each panel. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

We further examine the relative odds of being employed in a particular job or industry sector for young and prime-age adults in response to changes in the elderly employment rate using a multinomial logit regression model. In Table 6, skill levels are classified as unskilled or semi-skilled jobs and professional or skilled jobs. For unskilled or semi-skilled jobs, an increase in the employment rate of older men reduces the relative odds of being employed for prime-age men (Table 6, Panel A, Column 2) whereas increases in both older men's and older women's employment rates raise the relative odds of being employed for prime-age women (Table 6, Panel A, Column 5). These results indicate that older men are more likely to compete with prime-age men for unskilled or semi-skilled jobs whereas older women's employment encourages prime-age women's employment for unskilled or semi-skilled jobs.

With respect to professional or skilled jobs, an increase in both older men's and women's employment rates raises the relative odds of being employed for young women (Table 6, Panel B, Column 4). Furthermore, an increase in the employment rate of older women is likely to lead to an increase in prime-age women's employment (Table 6, Panel B, Column 5) and a decrease in older men's employment (Table 6, Panel B, Column 3, Row 2). Overall results imply that elderly employment stimulates the labor supply of prime-age women for unskilled or semi-skilled jobs while it stimulates the labor supply of young women for professional or skilled jobs.

Table 6. Relationship between elderly employment and employment status of young and prime-age people, by skill level

VARIABLES	(1) Young Male	(2) Prime-age Male	(3) Old Male	(4) Young Female	(5) Prime-age Female	(6) Old Female
Panel A: Unskilled or semi-skilled jobs						
Older men's employment	-0.017	-0.011**	.	-0.004	0.016***	-0.006
	(0.012)	(0.005)	(.)	(0.009)	(0.003)	(0.006)
Older women's employment	0.016	-0.003	0.014*	0.005	0.023***	.
	(0.015)	(0.005)	(0.008)	(0.012)	(0.004)	(.)
Panel B: Professional or skilled jobs						
Older men's employment	0.012	-0.002	.	0.061**	0.007	-0.012
	(0.029)	(0.006)	(.)	(0.025)	(0.007)	(0.014)
Older women's employment	0.031	0.001	-0.058***	0.071**	0.030***	.
	(0.034)	(0.007)	(0.016)	(0.029)	(0.008)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	5,534	65,142	14,758	7,859	64,896	15,661

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively under each panel. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

Due to insufficient sample size drawn from KLIPS, 17 industry sectors[13] are aggregated to 5 sectors[14]. Table 7 presents the relative odds of being employed in a given industry sector in response to changes in the elderly employment rate. For young adults, the elderly employment rate has no impact on their employment status regardless of industry. Among prime-age adults, men are more likely to be employed in the sales and service sector whereas women are more likely to be employed in all industry sectors as the employment rate of older men rises. Similarly, an increase in the employment rate of older women raises the relative odds of being employed for prime-age women in all sectors except the communication, information, finance and insurance sectors. Older women are less likely to be employed in the sales and service sectors as the employment rate of older men rises ($p<0.01$, Table 7, Panel A, Column 6) whereas older men are less likely to be employed in the communication, information, finance, and insurance sectors as the employment rate of older women rises although it is marginally significant ($p<0.1$, Table 7, Panel C, Column 3).

The magnitudes of substitutability and complementarity between older workers and young and prime-age workers vary by industry sector, however, the sales and service sectors show the largest gender difference in the relationship between employment of older adults and prime-age adults of the same gender: older men are more likely to substitute for prime-age men whereas older women are more likely to complement prime-age women in these sectors.

[13] KLIPS follows the Korean Standard Industrial Classification (Statistics Korea, 2017).

[14] Category 1 includes whole or retail sales, transportation and storage, accommodation and food services, professional, scientific and technical services, administrative and support services, Category 2 includes communication, information, finance, and insurance sectors, Category 3 includes public administration, educational services, health care, and social assistance sectors, Category 4, as Others, include agriculture, forestry, fishing, mining, manufacturing, utilities, construction, real estate and rental and leasing, arts, entertainment and recreation, activities of household, and activities of extraterritorial organizations and bodies. Category 5, as a reference group, includes all individuals who are not employed, either unemployed or not in the labor force.

Table 7. Relationship between elderly employment and employment status of young and prime-age people, by industry

VARIABLES	(1) Young Male	(2) Prime-age Male	(3) Old Male	(4) Young Female	(5) Prime-age Female	(6) Old Female
Panel A: Whole or retail sales, transportation and storage, accommodation and food services, professional, scientific and technical services, administrative and support services						
Older men's employment	-0.021	-0.013***	.	0.018	0.015***	-0.023***
	(0.016)	(0.005)	(.)	(0.012)	(0.004)	(0.008)
Older women's employment	0.016	-0.001	0.005	0.022	0.017***	.
	(0.020)	(0.006)	(0.010)	(0.014)	(0.005)	(.)
Panel B: Communication and information, and finance and insurance						
Older men's employment	-0.004	0.005	.	-0.019	0.029***	-0.026
	(0.056)	(0.008)	(.)	(0.029)	(0.008)	(0.026)
Older women's employment	0.101	-0.009	-0.057*	0.001	0.009	.
	(0.074)	(0.009)	(0.034)	(0.035)	(0.010)	(.)
Panel C: Public administration, educational services, and health care and social assistance						
Older men's employment	0.019	-0.011	.	0.003	0.014***	-0.005
	(0.031)	(0.007)	(.)	(0.013)	(0.005)	(0.014)
Older women's employment	-0.020	-0.008	-0.006	0.025	0.026***	.
	(0.041)	(0.008)	(0.017)	(0.016)	(0.005)	(.)
Panel D: Others						
Older men's employment	-0.017	-0.007	.	-0.010	0.015***	0.009
	(0.016)	(0.005)	(.)	(0.014)	(0.004)	(0.007)
Older women's employment	0.012	0.000	0.014	0.002	0.033***	.
	(0.019)	(0.005)	(0.009)	(0.017)	(0.005)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	5,534	65,142	14,758	8,575	64,896	15,661

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively under each panel. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

As mentioned earlier, the Korean economy started slowing down from its booming economy in the 1970s, 1980s, and early 1990s and experienced the Asian financial crisis in the year 1997-1998. The Korean economy gradually recovered from the financial shock but it slowed down again after 2005 when China joined the World Trade Organization. To address the impact of the slow economy on the relationship between elderly employment and youth employment, we separate the study period into two groups: 1998-2004 and 2005-2017.

Table 8 shows no relationship between elderly employment and youth employment regardless of the time frame we use for both genders. Regarding prime-age men's employment, only the employment rate of older men has a statistically significant negative effect after 2005, reducing the likelihood of being employed for prime-age men. Regarding prime-age women's employment, the employment rates of both older men and older women have a statistically significant positive effect regardless of the time frame, increasing the probability of being employed for prime-age women. These results confirm the substitutability between older men and prime-age men in the labor market as observed in Table 3 and indicate that the substitutability effect has become stronger since 2005.

Table 8. Relationship between elderly employment and employment status of young and prime-age people, before 2005 vs. 2005 and after

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Young Male	Prime-age Male	Old Male	Young Female	Prime-age Female	Old Female
Panel A: Before 2005						
Older men's employment	-0.016	0.015	.	0.015	0.037***	-0.010
	(0.029)	(0.015)	(.)	(0.025)	(0.013)	(0.039)
Older women's employment	0.044	0.001	0.002	-0.016	0.028*	.
	(0.037)	(0.017)	(0.038)	(0.030)	(0.015)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	2,668	22,431	4,136	3,978	22,251	4,357
Panel B: 2005 and after						
Older men's employment	0.002	-0.021**	.	-0.005	0.016**	-0.010
	(0.025)	(0.009)	(.)	(0.019)	(0.007)	(0.018)
Older women's employment	0.011	-0.006	-0.017	0.037	0.020**	.
	(0.030)	(0.012)	(0.023)	(0.024)	(0.008)	(.)
Region dummy	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	3,588	42,711	10,700	4,597	42,645	11,420

*statistically significant at the 0.10 level; **statistically significant at the 0.05 level; ***statistically significant at the 0.01 level.

Note: The ward average elderly employment rates for men and women are listed in the first and third rows respectively under each panel. The standard error is in parenthesis. Source: Authors' calculation using KLIPS 1998-2017.

6. Robustness checks

6.1 Individual-level logistic regression analysis using pooled KPC

For robustness checks, we use the KPC data in 1990, 1995, 2000, and 2005. We regress older men's ward average employment rates on the employment status of individuals in other age and gender groups to check the relationship between elderly employment and the employment status of young and prime-age individuals. Table 9 shows that an increase in the employment rate of older men does not affect the employment status of young male and female workers while it has a statistically significant impact on prime-age adults. An increase in older men's employment significantly increases the likelihood of being employed for prime-age men while it decreases the likelihood for prime-age women (Table 9, Column 2 and 4). Regarding older men's substitutability with prime-age women and complementarity with prime-age men that KPC suggests, which are different from what we find using KLIPS, it is important to note that the KPC data includes years 1990 – 2005 whereas the KLIPS data includes years 1998 - 2017. As it started 8 years earlier than KLIPS, the KPC data contains labor market information before the Asian financial crisis while KLIPS data comprises labor market outcomes after the financial shocks. The time difference between the two datasets may create dissimilarities of the results.

Table 9. Relationship between older men's employment and the employment status of young and prime-age people at the individual level using the Korean Population Census Data, 1990 - 2005

VARIABLES	(1) Young Male	(2) Prime-age Male	(3) Young Female	(4) Prime-age Female	(5) Old Female
Older men's employment	0.018	0.039	-0.056	-0.036	0.379
	(0.565)	(4.616)	-(1.797)	-(2.747)	(13.730)
Age	0.016	0.077	0.700	0.000	-0.051
	(0.430)	(164.700)	(19.430)	(0.235)	-(2.514)
Age square	0.001	-0.001	-0.015	-0.00002	0.000
	(1.600)	-(155.800)	-(17.900)	-(1.889)	(1.632)
Years of schooling	-0.092	0.009	-0.027	-0.003	-0.008
	-(110.700)	(62.080)	-(32.490)	-(11.482)	-(18.800)
Share of population	0.274	0.199	1.708	-0.614	0.565
	(1.142)	(5.575)	(8.826)	-(11.490)	(4.287)
Share of students	-1.049	-0.55	-1.686	0.403	-0.092
	-(5.957)	-(13.280)	-(10.070)	(5.995)	-(0.840)
Share of high school graduates or less	-0.036	-0.078	0.080	0.026	0.059
	-(1.249)	-(10.550)	(2.965)	(1.937)	(2.344)
Share of self-employed	0.167	0.120	0.045	0.641	0.989
	(3.527)	(8.824)	(0.931)	(31.420)	(22.230)
Share of service employment	0.626	-0.086	0.671	1.001	0.224
	(3.873)	-(1.864)	(4.087)	(14.470)	(1.624)
Share of manufacturing employment	0.882	0.196	0.190	0.106	0.366
	(20.320)	(15.078)	(4.417)	(6.059)	(8.802)
Log GRDP per capita	-0.018	0.002	-0.012	-0.002	0.065
	-(0.812)	(0.272)	-(0.564)	-(0.173)	(3.090)
GRDP growth rate	0.236	0.092	0.245	0.152	0.176
	(3.474)	(4.845)	(3.643)	(5.201)	(2.827)
Constant	0.548	-0.806	-7.501	0.385	1.142
	(1.217)	-(13.880)	-(17.160)	(4.197)	(1.801)
Region dummy	YES	YES	YES	YES	YES
Year dummy	YES	YES	YES	YES	YES
R Squared	0.2	0.063	0.53	0.026	0.118
Observations	93,823	693,574	126,946	695,358	111,201

Note: The ward average elderly employment rate for men is listed in the first row. t-statistic is in parenthesis. Source: Authors' calculation using KPC, 1990, 1995, 2000, and 2005.

6.2 Ward-level logistic regression analysis using pooled KPC

We use the individual-level logistic regression analysis for the main analysis; however, a number of existing studies have used the province-level or state-level regression models to examine the relationship between elderly employment and youth employment. To compare our results with the results of existing studies, Table 10 provides the results of the ward-level logistic regression analysis measured using pooling KPC for years 1990, 1995, 2000 and 2005.

Similar to the main results of the study and the results measured at the individual-level using the pooled KPC date in Table 9, older men's employment has no statistically significant impact on youth employment.

Similar to the results in Table 9, we find a positive relationship between the employment of older men and prime-age men and a negative relationship between the employment of older men and prime-age women. Overall results confirm no substitutability between older workers and young workers for both genders regardless of data and level of analysis.

Table 10. Relationship between older men's employment and the employment status of young and prime-age people at the city level using the Korean Population Census Data, 1990 - 2005

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Young Male	Prime-age Male	Young Female	Prime-age Female	Old Female
Older men's employment	0.013	0.041	-0.046	-0.054	0.345
	(0.279)	(2.652)	(-1.019)	(-2.413)	(7.159)
Share of population	0.655	0.526	1.986	-0.505	0.243
	(1.795)	(8.263)	(7.023)	(-5.330)	(0.989)
Share of students	-1.859	-0.539	-1.958	0.387	-0.111
	(-7.137)	(-7.340)	(-8.110)	(3.330)	(-0.537)
Share of high school graduates or less	0.119	-0.15	0.073	0.026	0.13
	(2.466)	(-9.522)	(1.591)	(0.985)	(2.559)
Share of self-employed	0.099	0.144	0.183	0.717	1.036
	(1.495)	(6.086)	(2.755)	(20.939)	(12.703)
Share of service employment	0.464	-0.177	0.756	0.742	-0.297
	(2.122)	(-2.408)	(3.461)	(7.031)	(-1.307)
Share of manufacturing employment	0.886	0.128	0.326	0.08	0.231
	(13.214)	(5.010)	(4.852)	(2.463)	(3.028)
Log GRDP per capita	-0.011	0.004	0.091	0.001	0.054
	(-0.315)	(0.354)	(2.622)	(0.062)	(1.445)
GRDP growth rate	0.245	0.123	0.124	0.1	0.241
	(2.232)	(3.309)	(1.141)	(1.865)	(2.092)
Constant	0.233	0.725	-0.517	0.305	-0.845
	(0.785)	(6.744)	(-1.758)	(1.929)	(-2.695)
Region dummy	YES	YES	YES	YES	YES
Year dummy	YES	YES	YES	YES	YES
R Squared	0.784	0.822	0.602	0.909	0.852
Number of observations	593	593	593	593	593

Note: The ward average elderly employment rate for men is listed in the first row. t-statistic is in parenthesis. Source: Authors' calculation using KPC, 1990, 1995, 2000, and 2005.

7. Discussion and Conclusion

This paper examines the relationship between elderly employment and labor market outcomes of young and prime-age adults in Korea using longitudinal and cross-sectional data. Various labor market outcomes available in KLIPS allow the study to examine how not only the employment status but also the unemployment status, hours of work, and wages of young and prime-age individuals can be associated with changes in elderly employment. Individual-level data that can be stratified based on age, gender, education, skill, and industry sector enable the study to estimate the magnitude and variation of the association between individuals of different ages.

The main results of the study show no statistically significant association between elderly employment and youth employment. These results are aligned with findings of international literature (Munnel & Wu, 2012; Kondo, 2016) as well as of Korean literature (Ahn, 2011; D. I. Kim, 2004; J. Y. Kim, 2011) showing that an increase in employment of older people does not crowd out young people from labor markets. Unlike no substitutability found between young and older workers, we find a statistically significant relationship between the employment of older adults and prime-age adults. Prime-age women are likely to complement both older men and older women while prime-age men are likely to substitute for older men in the labor market, suggesting gender differences in the association between the employment of prime-age workers and older workers. These results are comparable to the findings of Kalwij et al (2009) providing evidence that older workers can complement prime-age workers, although it was not apparent which gender contributes more to this complementary relationship.

The main results with the employment status are replicated with other labor market outcomes including the unemployment status, hours of work, and weekly wages. We do not find any evidence of a statistically significant relationship between elderly employment and the unemployment status of young and prime-age adults. Existing studies showing no association between elderly employment and unemployment of young and/or prime-age individuals in China, Japan, and the U.S. (Munnel & Wu, 2012, Oshio et al., 2012) confirm the finding of this study. No statistically significant relationship between elderly employment and young adults' working hours and weekly wages are parallel to the relationship that Munnel and Wu (2012) have found between older workers and young workers in the U.S. Ji (2012) has further shown evidence that older workers do not compete with young workers for low-paying jobs. A negative relationship between older men's employment and prime-age men's working hours and weekly wages and a positive relationship between both older men's and older women's employment and prime-age women's working hours and weekly wages that this study finds strengthen the main findings of the study: the substitutability between the employment of older men and prime-age men and the complementarity between the employment of older men and women and prime-age women.

From the subgroup analysis stratified by level of education, we find that older male workers with college degrees or higher are more likely to substitute for young and prime-age female workers regardless of their levels of education. Similar to the study of Munnel and Wu (2012) showing a positive association between older workers and young workers with low educational backgrounds in the Chinese labor market, this study finds that elderly employment is positively associated with the employment status of young people of the same gender, particularly when their educational levels are the same. The subgroup analysis based on skill level indicates that older men are likely to compete with prime-age men while they assist in prime-age women's employment for unskilled or semi-skilled jobs. Older women's employment, on the other hand, is likely to motivate the employment of young and prime-age women for professional or skilled jobs. Similar to Shin's study (2009), we do not find any evidence of substitutability between older workers and young unskilled workers.

A higher employment rate of older adults encourages the employment of prime-age women in all industry sectors. The substitutability between older male workers and prime-age male workers and the complementarity between older female workers and prime-age female workers are most evident in the sales and service sectors. The results of the study are analogous to the findings of several Korean studies (Keum, 2007; Kwon, 2010; Lee et al., 2015; Shin, 2009) suggesting that the types of jobs or industry sectors in which young people are likely to be concentrated are different from those in which older people are likely to be employed. Similar to the studies of Lee et al. (2015) and Shin (2009) finding no association between elderly employment and youth employment in the service and manufacturing sectors, this study finds no statistically significant association between older workers and young workers in all industry sectors.

Several limitations of the study need to be discussed. First, it is important to note that there have been some policy changes in Korea including the establishment of the mandatory retirement age, the implementation of senior employment programs, and the expansion of basic pension benefits over the past two decades. These changes might have affected labor force participation decisions as well as labor market outcomes of young, prime-age, and older people in Korea. Second, KLIPS focuses on individuals in urban areas. As the level of education, availability of skilled jobs, the share of industry sectors, and many other demographic and socioeconomic factors may vary by region, we might have not adequately addressed regional differences while examining the association between elderly employment and youth employment. Lastly, the level of education has significantly increased over the past 20 years. Along with increasing average years of schooling, a higher level of labor force participation has expected especially among young people. However, with a larger number of young people stay in college at the age of 20 to 24 and the longer time they take for career preparation and job search, young people aged 20 to 24 might not be the best age group to examine the association between elderly employment and youth employment.

The lump-of-labor theory is an interesting hypothesis to test within the context of the Korean labor market. To investigate the association between elderly employment and labor market outcomes of young and prime-age adults, the study employs both longitudinal and cross-sectional data. Given that the study finds no relationship between elderly employment and both the employment and unemployment status of the youth, it leaves room for further research on the factors that affect youth unemployment and determinants of elderly employment. The urban-rural comparison of the association between the employment of young and older workers may help policymakers to better design employment policies for people of different age, gender, and region.

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