# Health Capacity to Work at Older Ages in the Republic of Korea

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Using the Milligan and Wise (2015) and Cutler, Meara, and Richards-Shubik (2013) methodologies, we examine (i) how much would people today with a given mortality rate or life expectancy work if they were to work as much as those with the same mortality rate worked in the past, and (ii) how much could older adults extend their working lives if their health status improved. The results point to a sizable health capacity to work (HCW) among both older Korean men and women. Furthermore, the results imply that HCW is concentrated among more educated urban senior residents with access to the statutory pension system. We explain our results in the context of the Republic of Korea's labor markets and old-age support systems. The results for the Republic of Korea imply that the previous results for other high-income economies, such as European countries and the United States, may not be applicable to high-income economies with underdeveloped pension systems.

*Keywords:* health capacity to work, old-age support system, pension, population aging, Republic of Korea

*JEL codes:* J11, J14, J19

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## I. Introduction

Due to a decline in fertility and an increase in life expectancy, East Asian countries such as the Republic of Korea are experiencing a rapid change in their age structures. In these economies, demographic change is a major socioeconomic risk that can undermine social cohesion, breed social conflict, and hinder sustainable growth (Bloom, Canning, and Fink 2010; Lee 2016). Markets cannot adequately address the risks and, in the Korean context, underdeveloped public support systems leave older people vulnerable to economic insecurity. Complicating an effective policy response is a growing fiscal burden due to the expansion of social welfare programs, intergenerational conflict, and poverty among the older population.

Successive Korean governments have taken policy measures to mitigate the negative impact of population aging. One main reform was the retention of older workers, for example, by increasing the retirement age. When people live longer and healthier lives, healthy older workers can contribute to their own economic security and help sustain economic growth. The question then becomes how much more can older people work given their health status and mortality. The central objective of our paper is to quantify the health capacity to work (HCW) among older males and females in the Republic of Korea.

A growing body of literature examines the relationship between health improvements and work capacity. For instance, an International Social Security (ISS) project team estimated the HCW in 12 countries (Coile, Milligan, and Wise 2017). Matsukura et al. (2018) calculated the HCW of older Japanese people and showed that there is a substantial untapped work capacity in Japan. However, little is known about the Republic of Korea. Lee (2014) found that older Korean workers aged 50–64 years in good or very good health are more likely to work, by about 10 percentage points, than those in poor or fair health. Using the Milligan–Wise (MW) method (Milligan and Wise 2015), Kim (2019) found additional employment capacity in the Republic of Korea.

Using time series data on employment and the mortality rate, and eight waves of the Korean Longitudinal Study of Aging (KLoSA) between 2006 and 2020, we estimate the HCW in the Republic of Korea.[1] We improve upon the previous literature in a few ways. First, we estimate the HCW in the Republic of Korea for both men and women. Research on female cases is relatively rare and a study on the HCW for older females can yield some important insights since the pattern of labor force participation

[1]Korea Employment Information Service. Korean Longitudinal Study of Aging (KLoSA). https://survey.keis.or.kr/eng/klosa/klosa01.jsp (accessed 1 March 2022).

among women usually differs from that of men. Second, we apply both the MW method and the Cutler–Meara–Richards-Shubik's (CMR) method (Cutler, Meara, and Richards-Shubik 2013) and compare the results. To our best knowledge, there is no previous study of the Republic of Korea that used both methods. Finally, we conduct several sensitivity analyses to check the robustness of our results. For instance, we experiment with different base age groups and simulated age groups. We also divide the sample into urban versus rural residents since in the Republic of Korea, rural residents are much less likely to face a statutory retirement age.

The rest of this paper is structured as follows. Section II briefly describes the landscape of population aging and the labor market in the Republic of Korea. Section III presents the datasets and methodologies used for our empirical analysis. Section IV reports and discusses the estimation results. Section V concludes the paper, presents the policy implications, and explains the limitations of our analysis.

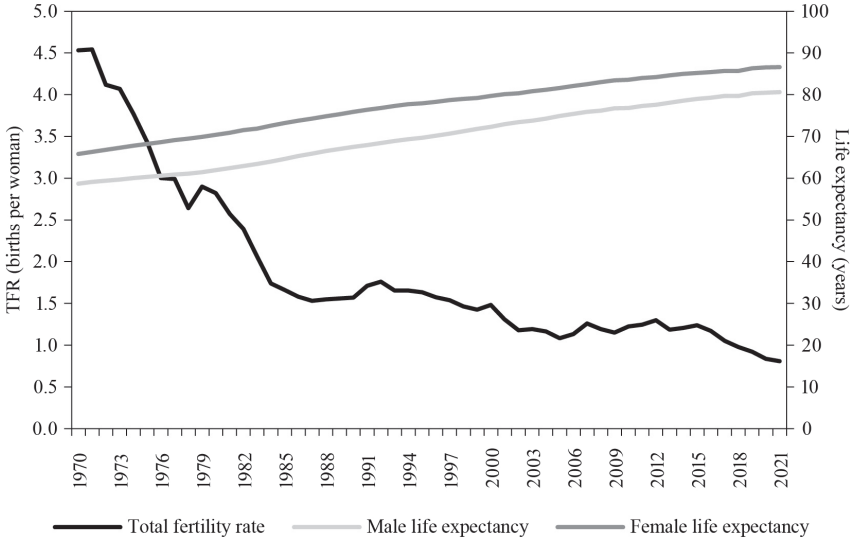
## II. Older Workers in the Republic of Korea

In this section, we briefly describe the landscape of population aging and the labor market in the Republic of Korea.

### A. Population Aging

The Republic of Korea is an important study case for several reasons. Most of all, it has been experiencing very rapid population aging (Figure 1). The share of the older population (aged 65 years and above) grew from 3.1% in 1970 to 14.3% in 2018. The share of the older population is projected to reach 40% in 2050 (Statistics Korea 2022). The rapid population aging of the Republic of Korea is in large part due to its extremely low and decreasing total fertility rate (TFR), which decreased from 4.53 births per woman in 1970 to 2.06 in 1983, or to just around the population replacement level. It then fell to about 1.6 and held there from the mid-1980s to the mid-1990s. It fluctuated between 1.05 and 1.30 from 2002 to 2017. However, the TFR has decreased further and remained below 1.00 since 2018 when it dipped to 0.98 and then further to 0.92 in 2019, 0.87 in 2020, 0.81 in 2021, and 0.78 in 2022, which represented the lowest TFR in the world. On the other hand, life expectancy has been increasing. The introduction of Western medical and health-care facilities, better standards of living, and sharp increases in educational attainment, among other factors, led to a dramatic rise in life expectancy in the Republic of Korea to 70.1 years (men 65.9, women 74.4) in 1987 from 62.3 years (male 58.7, female 65.8) in 1970. Life expectancy in the

Figure 1. **Total Fertility Rate and Life Expectancy at Birth, 1970–2021**




TFR = total fertility rate.
Source: Statistics Korea. Korean Statistical Information Service. www.kosis.kr (accessed 1 February 2023).

Republic of Korea also continued to improve over the next 3 decades, rising to 83.6 years (men 80.6, women 86.6) in 2021.

## B. Older Korean Workers

The labor force participation rates of older Korean people are the highest among Organisation for Economic Co-operation and Development (OECD) countries (Figure A1 of the Appendix).[2] Whereas the average labor force participation rate of people aged 65 years and older among OECD members was 15.4% in 2021, the Republic of Korea's rate was 36.3%.[3] The labor force participation of older Koreans aged 65–69 was also very high in 2021 at 45.5%, based on data from Statistics Korea.[4]

However, the number of temporary workers as a share of the total population of older Koreans is also the highest among all OECD countries (Figure A2 of the Appendix). While the share of temporary workers in the Republic of Korea is relatively

[2]To view all appendixes, please refer to the supplementary materials that are available at: https://www.worldscientific.com/doi/suppl/10.1142/S0116110524400067.

[3]OECD. OECD Data. data.oecd.org (accessed 20 December 2022).

[4]Statistics Korea. Korean Statistical Information Service. www.kosis.kr (accessed 1 March 2023).

high at 28.3%, the share of temporary workers aged 65 years and older is much higher at 70.9%. This phenomenon is related to the fact that older workers are concentrated in some industries and occupations that are characterized by temporary and low-paying jobs. For example, about 45% of employed older Koreans are working in business facilities and management positions such as building guards (footnote 4). This high percentage is remarkable, considering the share of all Korean workers employed in these sectors is only 17%. The share of older workers in high-paying sectors, such as telecommunications and financial insurance, is meager in the Republic of Korea.

Older Koreans are retiring in large part for involuntary reasons (footnote 4). About 31% of people aged 55–64 years who retired in 2022 did so due to their company closing down, while about 20% of people who retired that same year did so for health-related reasons (Table A1 of the Appendix). More than 26% of older women retiring in 2022 did so to take care of other family members, but only about 2% of men retired for the same purpose. About 13% of men who retired in 2022 did so because they had reached the normal retirement age, while compared with less than 4% of women. The poverty rate of older people aged 65 years and over in the Republic of Korea is very high too at 43.8%, the highest among all OECD countries, which has an average poverty rate of only 13.5% among older persons.

To summarize, the population of older Koreans is characterized as having a high labor force participation rate, a high percentage of temporary workers, and high poverty rates. This might be primarily due to inadequate public pension schemes for older adults. Korean seniors depend on two public programs; the basic welfare program and the national pension system. The basic welfare program (Basic Livelihood Security Program) is a welfare system that provides cash and other benefits such as housing and education for citizens earning below 40% of the median income.[5] However, this program does not offer complete relief to seniors as it has strict eligibility criteria that turn away many people from the program. The primary public pension system, the National Pension Scheme, was created in 1988 and initially covered all companies with at least 10 employees. It expanded coverage to include companies with five employees in 1992 and subsequently included all companies in 2003. The self-employed were also included in this pension scheme in 1999. Residents living in regions associated with retirement pension plans can also join. Despite its expansion over time, only about one-third of older Koreans are receiving old-age pensions from the National Pension Scheme (footnote 4). Furthermore, the general government's public social spending as a share of

[5]The Government of the Republic of Korea changed the official poverty line from the minimum cost of living (absolute criterion) to 40% of the median income (relative poverty line) in 2015.

the gross domestic product in the Republic of Korea is the lowest among all OECD countries and only half of the OECD average.

The Republic of Korea is also among the countries with the lowest pension replacement rates in the OECD.[6] The future gross (net) replacement rate for full-career workers in the Republic of Korea is 37.3% (43.4%) (OECD 2019). Among OECD countries, only a few such as Chile or Lithuania have a lower pension replacement rate than the Republic of Korea. Besides, the share of self-employed workers is much higher in the Republic of Korea, reaching 25.1% in 2018 (footnote 3), and their replacement rate is much lower than those of full-career employees (OECD 2019). The traditional family support system has also been deteriorating in the Republic of Korea. Thus, together with the insufficient pension system, the incentive for older persons in the Republic of Korea to continue working is currently very high. However, given the tight labor market, they are driven into bridge jobs, which are characterized by their temporary nature. In the following two sections, we will estimate the HCW at older ages and the extent of potential gains at the national level. The estimated results will be explained using these old-age support systems and the labor market characteristics of the Republic of Korea.

## III. Methodology and Data

In this section, we explain the two most widely used methods for estimating the HCW of older people: the MW and CMR methods.

### A. Methodology

The MW method employs the relationship between mortality and employment, using a decrease in mortality as a proxy for improvement in health status over time to estimate the potential gains in employment. Then, the difference in the two employment rates is interpreted as the HCW. Milligan and Wise (2015) showed a substantial HCW in all 12 ISS project countries.

Our estimation utilizes two measures, mortality rate and life expectancy, as proxies for improvement in health status between 2000 and 2020. Thus, it answers the

[6]The pension replacement rate is defined as the individual pension entitlement divided by preretirement earnings. Net replacement rates account for personal income taxes and social security contributions paid by workers. However, this calculation should be interpreted with caution as it assumes that full-career workers are employed from age 22 until retirement. The estimated replacement rate in the Republic of Korea could be substantially overestimated as many Koreans leave their career jobs around age 50.

question of "how much more older people could work in 2020 if they worked as much as those with the same mortality rate or life expectancy rate in 2000." One caveat of the MW method is that the estimation results could be quite sensitive to comparison years, and the year selection is arbitrary. Another caveat is that it may be challenging to interpret the results if there are substantial structural changes in labor force participation rates. This is especially true for females as their pattern of labor force participation changes dramatically over time compared with their male counterparts.

Second, the CMR method measures the HCW as the difference between the actual and simulated employment rates. When simulating the employment rate, the CMR method assumes that the relationship between health and employment of younger people is the same as that for older people. The comprehensive study on HCW was carried out by the ISS project team in each participating country (Coile, Milligan, and Wise 2017), revealing vast additional potential for HCW at older ages in all 12 countries. Using the CMR method, Matsukura et al. (2018) also showed that there are more than 10 million potential workers aged 60–79 years in Japan.

Our estimation comprises two steps. First, we run a baseline regression to get the relationship between health conditions and work status for people aged 50–59 years (younger group). Next, we simulate the HCW for those aged 60–79 years (older group), assuming that the relationship between health status and an individual's capacity to work for the older group is the same as for their younger counterparts. The capacity to work, or the slack, is then calculated as the difference between the actual and simulated employment rates. Thus, our estimation results answer the question of "how much the older group could work if they, with a given level of health, were to work as much as their younger counterparts with comparable health status."

The results of the ISS project suggest that older workers are not working, although they can, in large part because generous pension benefits discourage older people from working. For many developed countries, this is likely to be true as the labor force participation rate drops dramatically around the pension-eligible age. However, the Republic of Korea's labor force participation rates do not decline dramatically around the pension-eligible age. In fact, it drops almost linearly as older people age. As mentioned in the previous section, this might be because only about one-third of older Koreans are recipients of old-age pensions. Also, since Korean pension incomes are not necessarily sufficient for supporting daily life, older people are encouraged to work longer. To address this issue, we simulate the HCW for various subgroups—for example, by gender, residency (rural versus urban), and type of job (employed versus self-employed). Holding the other characteristics constant, it is expected that the HCW would be larger for the pension-eligible group, such as people

living in urban areas. As most of the previous studies have focused only on males, we will investigate the cases for both males and females and compare the results to draw some implications.

## B. Data

This study relies on two types of datasets. The first is used to estimate the HCW using the MW method. Information on age-specific employment rates is available from Korea's Economically Active Population Survey. The survey was first conducted in 1962 as a quarterly survey but changed to a monthly survey in 1982. Unfortunately, information is only available for 5-year age intervals. For our study, we used a spline interpolation to impute for in-between ages. In addition, the survey started to report data for ages 65–69 in 1995. Hence, consistent time series information on people ages 65 and above is only available from 1995. The definition of employment is the same as the guidelines of the International Labour Organization. A complete life table of Koreans is also available from Statistics Korea from 1970 onward. For this study, we utilize information on the probability of death and life expectancy, disaggregated by single age and sex, for 1980–2020.

The second dataset that we use to estimate the HCW based on the CMR method is derived from the eight waves of the KLoSA, a biennial survey that began in 2006 with 10,254 respondents aged 45 years and above. The survey includes detailed information on demographic characteristics, health outcomes, employment, income, and assets. The panel data consist of a nationally representative sample in 15 municipalities, but it excludes Jeju Island. We employ eight waves of the KLoSA spanning from 2006 to 2020.

For this comparative study, we use the following independent variables: (i) self-rated health status (5-point scale: poor, fair, good, very good, and excellent); (ii) variables measuring the prevalence of functional limitations such as activities on daily living (ADL) and limitations on instrumental activities of daily living (IADL), visual, hearing, or cognitive impairment;[7] (iii) variables indicating chronic illness such as

[7]A dummy variable for ADL is equal to 1 if the person has at least 1 difficulty with using a bathroom, wearing and taking off a dress, and eating, and 0 otherwise. A dummy variable for IADL is equal to 1 if the respondent has at least 1 difficulty with using a telephone, taking medication, handling money, shopping, and preparing meals, and 0 otherwise. Exact survey questions are available at https://survey.keis.or.kr/eng/klosa/klosa01.jsp. Meanwhile, cognitive skill measures are different across countries. For KLoSA they score cognitive ability via immediately (0–3) and delayed word recall (0–3), serial 7's (0–5), dates naming (0–3), day of week (0–1), naming first object (0–1), naming second object (0–1), drawing picture (0–1), repeat sentence (0–1), following direction (0–3), read and close eyes (0–2), and writing (0–1). The total score ranges from 0 to 25. Cognitive skill measurement categories are set as follows: 0–6 (severely impaired), 7–11 (mildly impaired), and 12 or higher (normal).

diabetes, high blood pressure, heart disease, cancer, asthma, arthritis, and back pain; (iv) variables measuring other health risk factors such as smoking, drinking, and being overweight, as well as depressive symptoms based on the Center for Epidemiologic Studies Depression (CES-D);[8] and (v) individual characteristics such as educational attainment, marital status, place of residence, province (resident) dummy variables, and survey years.

The variables are used for different models. Model (0) is the most parsimonious one that only includes self-rated health status, ADL, the number of chronic illnesses, smoking behavior, marital status, and place of residence. Model (1) includes a few additional variables such as diabetes, hypertension and heart disease, a CES-D measure, and educational attainment. Model (2) is a full model that includes all variables.

Older Korean males have very high employment rates, reaching about 87% for those aged 50–59 years (Table A2 of the Appendix). About 31% of Koreans aged 50–59 years have more than a tertiary education and about 17% live in rural areas. About 43% report poor or fair health, while 57% said their health status is either very good or excellent. About 5% of older Korean males report impairment of cognitive ability. The picture for older females of the same age group is somewhat different. Older Korean females ages 50–59 years are much less likely to be employed (51%) than their male counterparts. In general, older females report poorer health conditions than older males in the Republic of Korea (e.g., poor self-reported health [SRH], impairment of cognitive ability, cancer, arthritis, back pain, and depression). However, only about 2% of older women report smoking, which is in stark contrast with the very high smoking behavior of older men at 42%. Health deteriorates quite rapidly for both males and females as people age. The increase in cognitive impairment is especially notable for women, increasing from about 8% for ages 50–59 to 31% for ages 60–79. Almost half of the women aged 60–79 years report back pain problems, while less than 30% do for ages 50–59.

## IV. Estimation Results

In this section, we report and discuss results for models using both the MW and CMR methods. In addition to baseline results, we present the results of the extended analysis, which divides our sample into various subsamples (e.g., men and women).

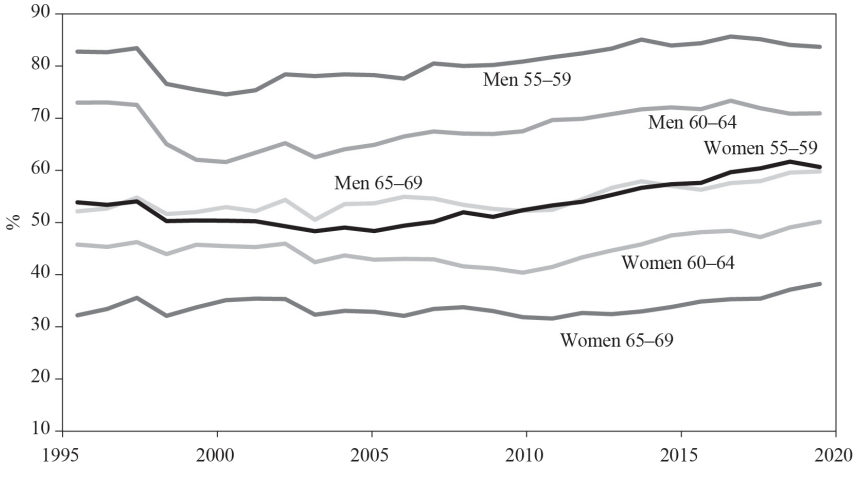
[8]CES-D measures depression by asking questions about whether a respondent felt depressive symptoms during the past week. It includes 10 items with a total score ranging from 0 to 30. CES-D is equal to 1 if the total score is more than 10 (cutoff $\geq$ 10), and 0 otherwise.

## A. Milligan–Wise Results

Figure 2 presents employment rate trends for Korean men and women between 1995 and 2020. Although it is not easy to distinguish the cyclical fluctuation components from trends, the figure shows some patterns—particularly, that the employment rate of men aged 55–64 years increased steadily after the 1997/98 Asian financial crisis. On the other hand, the increase in the employment rate of women aged 60–69 years was only notable after 2010. Finally, the coronavirus disease pandemic had a more negative impact on older men's employment than older women's.

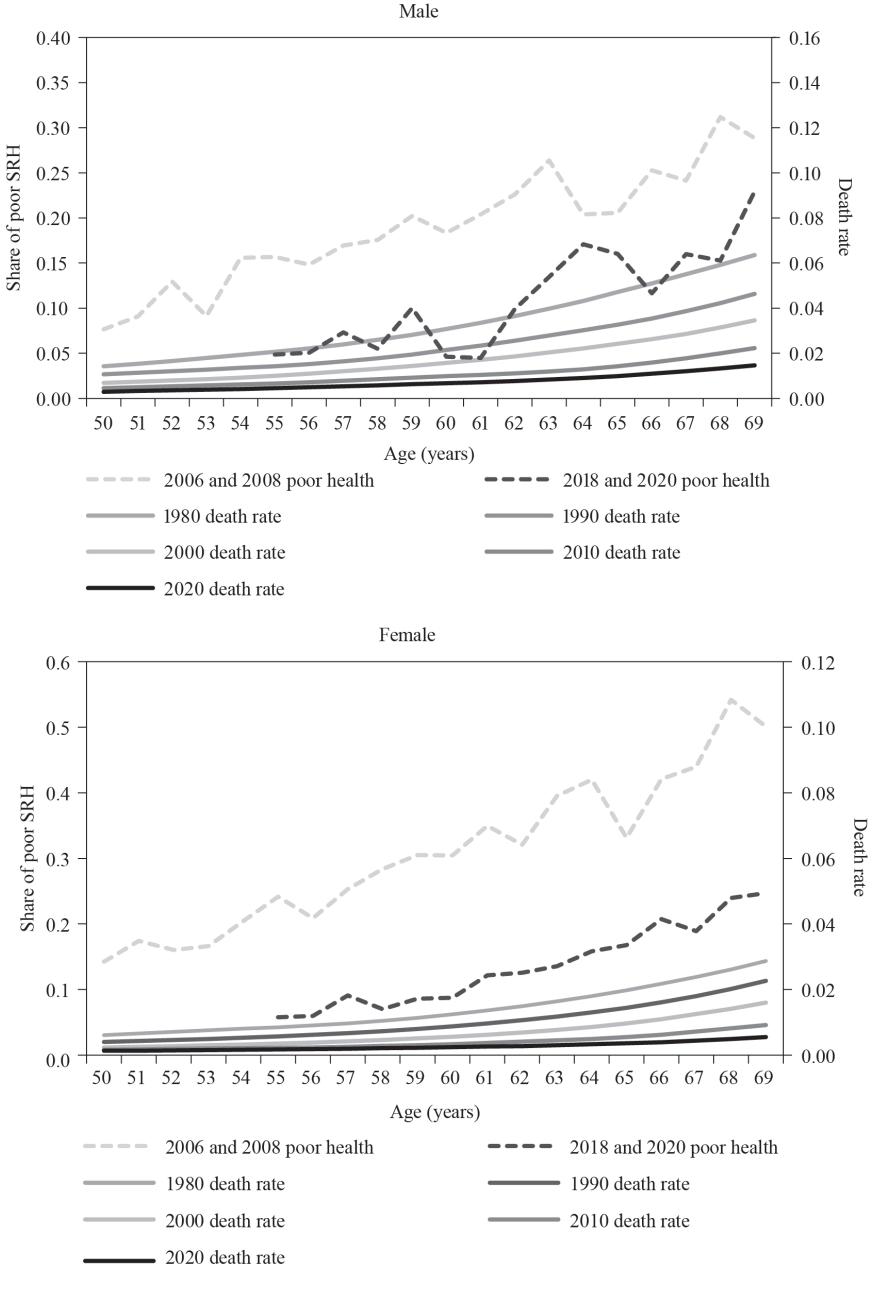
Figure 3 presents the long-term trends of mortality and SRH for men and women aged 50–69 years from 1980 to 2020. The data on mortality is from the complete life table from the Statistics Bureau, while data for SRH is drawn from the KLoSA. The figure demonstrates that the mortality rate steadily declined at all ages for both men and women. For example, the mortality rate for men aged 60 years declined from 3.1% in 1980 to 0.7% in 2020. The mortality rate for women aged 60 years shows a similar pattern, declining from 0.9% in 1980 to 0.3% in 2020. The proportion of people with poor SRH declined as well. About 18% of men and 30% of women aged 60 years had poor SRH in two waves of the KLoSA between 2006 and 2008. These percentages declined more than 70% by the 2018 and 2020 waves of the KLoSA, recording 4.6% for men and 8.7% for women.

Figure 2. **Long-Term Trend of Employment Rate by Gender and Age Group, 1995–2020**



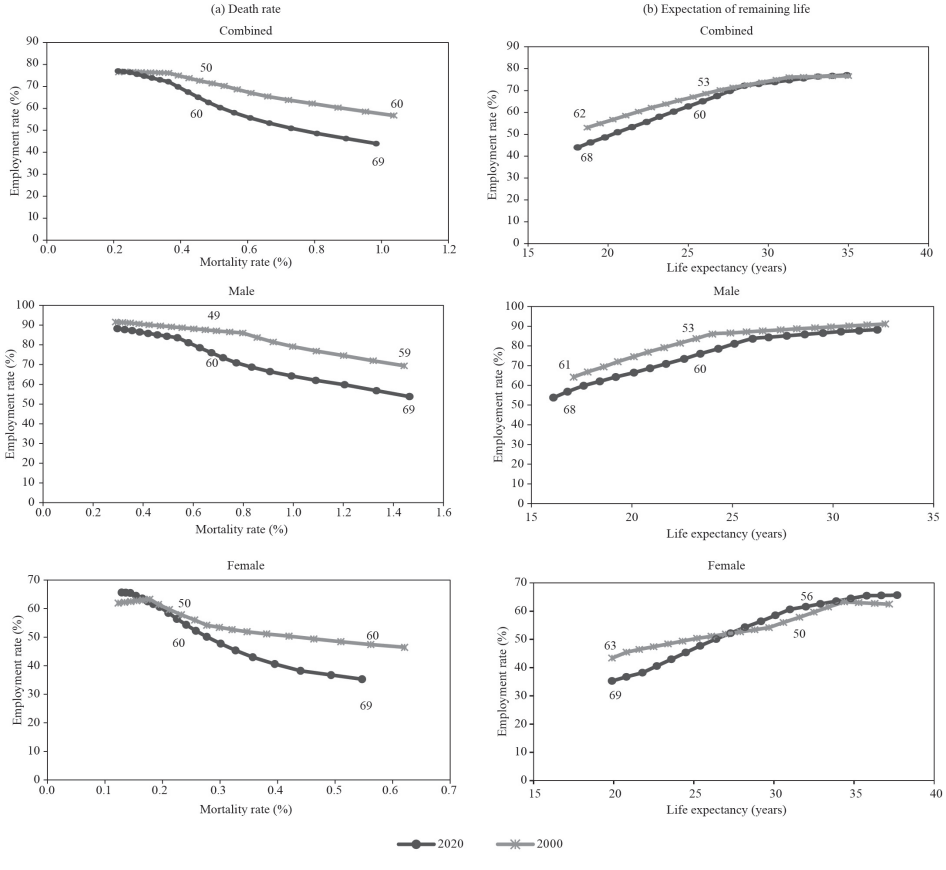

Source: Statistics Korea. Korean Statistical Information Service. Economically Active Population Survey. www.kosis.kr (accessed 1 March 2023).

Figure 3. **Mortality Trend and Share of Poor Self-Reported Health**




SRH = self-reported health.
Note: SRH is calculated by the authors using eight waves of the KLoSA.
Source: Statistics Korea. Korean Statistical Information Service. www.kosis.kr (accessed 1 October 2022).

Figure 4. **Employment Rates, Death Rates, and Life Expectancy, 2000 and 2020**




Source: Authors' calculations.

Figure 4 presents HCW based on the MW method. In 2000, the mortality rate for men aged 59 years was 1.4% and the employment rate was 69.4%. This mortality rate is similar to that of men aged 69 years in 2020, while the employment rate for men aged 69 years in 2020 was 63.8%. Therefore, the employment rate of Korean men aged 69 years in 2020 would have been 5.6 percentage points higher if they had worked as much as men with the same mortality rate worked in 2000. Likewise, the employment rate of Korean women aged 69 years in 2020 would have been 7.4 percentage points higher if they had worked as much as women with the same mortality rate worked in 2000.

We can apply the MW method to the employment–life expectancy relationship. For men in 2000, the expectancy of remaining life for men aged 59 years was

18.6 years and the employment rate at this age was 69.4%. This remaining life expectancy is similar to that of men aged 66 years in 2020, whose employment rate was 62.0%. Therefore, the employment rate of Korean men aged 66 years in 2020 would have been 7.4 percentage points higher if they had worked as much as men with the same life expectancy worked in 2000. Likewise, the employment rate of Korean women aged 66 years in 2020 would have been 6.8 percentage points higher if they had worked as much as women with the same remaining life expectancy worked in 2000. However, the HCW based on remaining life expectancy using the MW method is negative for all women below the age of 62 in 2020. This is in large part because older Korean women's employment rate in 2000 was much lower than in 2020, and the peak point in 2000 was also younger (age 45) than that in 2020 (age 49). Thus, the results based on the MW method should be interpreted with caution since there was a substantial structural change in female employment during the review period.

Tables 1 and 2 present the results for men and women aged 50–69 years in 2020. It shows how more men and women across this age range in 2020 could have worked if they had worked as much as those with the same mortality rate, or remaining life expectancy, worked in 2000. For example, at age 60, an additional 11.1% of men could have worked based on the mortality rate. If we repeat this for all age groups, the average remaining length of men's employment at ages 50–69 was 15 years in 2020. The HCW for this age group of men based on mortality (life expectancy) is an additional 1.9 years (1.4 years) or a 13.0% (9.5%) increase over the baseline years of work. For women, the average length of employment at ages 50–69 was 10.7 years in 2020. The HCW for this age group of women based on mortality (life expectancy) is only an additional 0.5 years (0.1 years) or a 4.5% (1.2%) increase over the baseline years of work. However, again, the results for women should be interpreted with caution, as the HCW is negative for people aged 60 years and below in 2020 in large part due to the increasing employment rate for women.

## B. Cutler, Meara, and Richards-Shubik Results

### 1. Regression Results

Table 3 reports the estimation results for the probable employment rate in the Republic of Korea. The results suggest that the health gradient is one of the most critical determinants for being employed. Among older Korean men, having poor SRH decreases the probability of working by more than 30 percentage points compared to those who have excellent SRH. On the other hand, the health status for older Korean

Table 1. **Health Capacity to Work by Gender and Age (Milligan–Wise Method)**

| A. Using Death Rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | | | | Female | | | |
| Age | Death Rate in 2020 (%) | Employment Rate (%) 2020 | Employment Rate (%) 2000 | Additional Employment Capacity (% point) | Death Rate in 2020 (%) | Employment Rate (%) 2020 | Employment Rate (%) 2000 | Additional Employment Capacity |
| 50 | 0.30 | 88.3 | 91.6 | 3.4 | 0.13 | 65.7 | 62.0 | −3.7 |
| 51 | 0.33 | 87.8 | 91.4 | 3.6 | 0.14 | 65.6 | 62.2 | −3.4 |
| 52 | 0.36 | 87.3 | 91.2 | 3.9 | 0.14 | 65.5 | 62.5 | −3.0 |
| 53 | 0.39 | 86.6 | 90.7 | 4.1 | 0.15 | 64.5 | 62.8 | −1.8 |
| 54 | 0.42 | 85.8 | 90.2 | 4.3 | 0.17 | 63.6 | 63.0 | −0.5 |
| 55 | 0.46 | 85.1 | 89.7 | 4.6 | 0.17 | 62.6 | 63.3 | 0.7 |
| 56 | 0.50 | 84.4 | 89.2 | 4.8 | 0.18 | 61.6 | 61.5 | −0.1 |
| 57 | 0.54 | 83.7 | 88.7 | 5.0 | 0.20 | 60.6 | 59.7 | −1.0 |
| 58 | 0.58 | 81.1 | 88.2 | 7.0 | 0.21 | 58.5 | 57.8 | −0.7 |
| 59 | 0.63 | 78.6 | 87.6 | 9.1 | 0.23 | 56.4 | 56.0 | −0.4 |
| 60 | 0.67 | 76.0 | 87.1 | 11.1 | 0.24 | 54.3 | 54.2 | −0.1 |
| 61 | 0.72 | 73.5 | 86.6 | 13.1 | 0.26 | 52.2 | 53.4 | 1.2 |
| 62 | 0.77 | 70.9 | 86.1 | 15.1 | 0.28 | 50.1 | 52.7 | 2.5 |
| 63 | 0.83 | 68.7 | 83.8 | 15.1 | 0.30 | 47.7 | 51.9 | 4.2 |
| 64 | 0.91 | 66.5 | 81.5 | 15.0 | 0.33 | 45.4 | 51.1 | 5.8 |
| 65 | 0.99 | 64.3 | 79.2 | 14.9 | 0.36 | 43.0 | 50.4 | 7.4 |
| 66 | 1.09 | 62.0 | 76.9 | 14.9 | 0.40 | 40.6 | 49.4 | 8.8 |
| 67 | 1.21 | 59.8 | 74.6 | 14.8 | 0.44 | 38.2 | 48.4 | 10.2 |
| 68 | 1.33 | 56.8 | 72.0 | 15.2 | 0.49 | 36.7 | 47.4 | 10.7 |
| 69 | 1.46 | 53.8 | 69.4 | 15.6 | 0.55 | 35.3 | 46.5 | 11.2 |
| Total years | | 15.0 | | 1.9 | | 10.7 | | 0.5 |
| % | | | | 13.0 | | | | 4.5 |

*Continued.*

Table 1. *Continued.*

**B. Using Life Expectancy**

| Age | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | Life Expectancy in 2020 (%) | Employment Rate (%) | | Additional Employment Capacity (% point) | Life Expectancy in 2020 (%) | Employment Rate (%) | | Additional Employment Capacity |
| | | 2020 | 2000 | | | 2020 | 2000 | |
| 50 | 32.2 | 88.3 | 91.2 | 2.9 | 37.7 | 65.7 | 62.5 | −3.2 |
| 51 | 31.3 | 87.8 | 90.7 | 2.9 | 36.7 | 65.6 | 62.8 | −2.8 |
| 52 | 30.4 | 87.3 | 90.2 | 2.9 | 35.8 | 65.5 | 63.0 | −2.5 |
| 53 | 29.5 | 86.6 | 89.7 | 3.1 | 34.8 | 64.5 | 63.3 | −1.2 |
| 54 | 28.6 | 85.8 | 89.2 | 3.3 | 33.9 | 63.6 | 61.5 | −2.1 |
| 55 | 27.7 | 85.1 | 88.7 | 3.6 | 32.9 | 62.6 | 59.7 | −2.9 |
| 56 | 26.8 | 84.4 | 88.2 | 3.8 | 32.0 | 61.6 | 57.8 | −3.8 |
| 57 | 26.0 | 83.7 | 87.6 | 4.0 | 31.0 | 60.6 | 56.0 | −4.6 |
| 58 | 25.1 | 81.1 | 87.1 | 6.0 | 30.1 | 58.5 | 54.2 | −4.3 |
| 59 | 24.3 | 78.6 | 86.6 | 8.0 | 29.2 | 56.4 | 53.4 | −3.0 |
| 60 | 23.4 | 76.0 | 86.1 | 10.0 | 28.2 | 54.3 | 52.7 | −1.7 |
| 61 | 22.6 | 73.5 | 83.8 | 10.3 | 27.3 | 52.2 | 51.9 | −0.3 |
| 62 | 21.7 | 70.9 | 81.5 | 10.5 | 26.4 | 50.1 | 51.1 | 1.0 |
| 63 | 20.9 | 68.7 | 79.2 | 10.5 | 25.4 | 47.7 | 50.4 | 2.6 |
| 64 | 20.1 | 66.5 | 76.9 | 10.4 | 24.5 | 45.4 | 49.4 | 4.0 |
| 65 | 19.2 | 64.3 | 74.6 | 10.3 | 23.6 | 43.0 | 48.4 | 5.4 |
| 66 | 18.4 | 62.0 | 72.0 | 10.0 | 22.7 | 40.6 | 47.4 | 6.8 |
| 67 | 17.6 | 59.8 | 69.4 | 9.6 | 21.8 | 38.2 | 46.5 | 8.2 |
| 68 | 16.8 | 56.8 | 66.8 | 10.0 | 20.8 | 36.7 | 45.5 | 8.7 |
| 69 | 16.1 | 53.8 | 64.2 | 10.4 | 19.9 | 35.3 | 43.4 | 8.1 |
| Total years | | 15.0 | | 1.4 | | 10.7 | | 0.1 |
| % | | | | 9.5 | | | | 1.2 |

Source: Authors' calculations applying the Milligan and Wise method.

Table 2. **Linear Probability Model Results for Employment—Men versus Women, Ages 50–59**

| Variable | (1) Male (0) | (2) Male (1) | (3) Male (2) | (4) Female (0) | (5) Female (1) | (6) Female (2) |
|---|---|---|---|---|---|---|
| **Self-reported health** (reference: very good or excellent) | | | | | | |
| Good | −0.029** | −0.032** | −0.031** | 0.001 | −0.000 | −0.002 |
| | (0.013) | (0.013) | (0.013) | (0.034) | (0.034) | (0.035) |
| Fair | −0.076*** | −0.077*** | −0.070*** | −0.039 | −0.044 | −0.036 |
| | (0.014) | (0.014) | (0.015) | (0.035) | (0.035) | (0.035) |
| Poor | −0.382*** | −0.359*** | −0.341*** | −0.202*** | −0.208*** | −0.167*** |
| | (0.025) | (0.025) | (0.026) | (0.037) | (0.037) | (0.038) |
| **Functional limitation** | | | | | | |
| Has 1 ADL difficulty | −0.393*** | −0.382*** | | −0.266*** | −0.269*** | |
| | (0.040) | (0.041) | | (0.059) | (0.059) | |
| Has 2 ADL difficulty | | | −0.311*** | | | −0.121* |
| | | | (0.042) | | | (0.071) |
| Has any IADL difficulty | | | −0.049*** | | | −0.138*** |
| | | | (0.017) | | | (0.044) |
| Has visual disability or impairment | | | −0.043 | | | 0.014 |
| | | | (0.042) | | | (0.042) |
| Has hearing disability or impairment | | | 0.083* | | | −0.023 |
| | | | (0.046) | | | (0.057) |
| Has cognitive function limitation | | | −0.076*** | | | −0.085*** |
| | | | (0.022) | | | (0.020) |
| **Health condition** | | | | | | |
| Number of chronic illnesses (0–3) (diabetes, hypertension, heart disease) | −0.008 | | | −0.026** | | |
| | (0.008) | | | (0.011) | | |

*Continued.*

Table 2. *Continued.*

| Variable | (1) Male (0) | (2) Male (1) | (3) Male (2) | (4) Female (0) | (5) Female (1) | (6) Female (2) |
|---|---|---|---|---|---|---|
| Diagnosed with diabetes | | −0.003 | −0.003 | | −0.001 | 0.003 |
| | | (0.014) | (0.014) | | (0.023) | (0.023) |
| Diagnosed with hypertension | | −0.007 | −0.014 | | −0.023 | −0.022 |
| | | (0.011) | (0.012) | | (0.015) | (0.015) |
| Diagnosed with heart disease | | −0.037 | −0.040 | | −0.118*** | −0.107*** |
| | | (0.035) | (0.035) | | (0.038) | (0.037) |
| Diagnosed with cancer | | | −0.012 | | | −0.158*** |
| | | | (0.040) | | | (0.027) |
| Diagnosed with asthma or lung disease | | | 0.099*** | | | −0.007 |
| | | | (0.036) | | | (0.049) |
| Diagnosed with arthritis | | | −0.038 | | | −0.050*** |
| | | | (0.029) | | | (0.017) |
| Diagnosed with back pain | | | −0.001 | | | 0.017 |
| | | | (0.012) | | | (0.013) |
| Diagnosed with depression | | −0.174*** | −0.164*** | | −0.007 | −0.002 |
| | | (0.036) | (0.035) | | (0.027) | (0.027) |
| **Risk factors** | | | | | | |
| Currently smoking | −0.009 | −0.010 | −0.013 | 0.001 | 0.003 | −0.029 |
| | (0.008) | (0.008) | (0.008) | (0.042) | (0.041) | (0.040) |
| Currently drinking alcoholic beverages | | | 0.019** | | | 0.076*** |
| | | | (0.009) | | | (0.013) |
| Overweight (BMI equal to or greater than 25) | | | 0.026*** | | | −0.006 |
| | | | (0.009) | | | (0.014) |

*Continued.*

Table 2. *Continued*.

| Variable | (1) Male (0) | (2) Male (1) | (3) Male (2) | (4) Female (0) | (5) Female (1) | (6) Female (2) |
|---|---|---|---|---|---|---|
| **Individual characteristics** | | | | | | |
| Highest education level attained (reference: high school) | | | | | | |
| Elementary school | | −0.053*** | −0.044** | | 0.031* | 0.042*** |
| | | (0.018) | (0.017) | | (0.016) | (0.016) |
| Middle school | | −0.004 | −0.002 | | 0.010 | 0.019 |
| | | (0.012) | (0.012) | | (0.015) | (0.015) |
| College education or above | | −0.029*** | −0.029*** | | −0.016 | −0.018 |
| | | (0.010) | (0.010) | | (0.020) | (0.019) |
| Currently married or living with a partner | 0.152*** (0.020) | 0.143*** (0.020) | 0.138*** (0.019) | −0.135*** (0.017) | −0.130*** (0.017) | −0.127*** (0.017) |
| Currently living in urban area | 0.012 | 0.009 | 0.008 | −0.125*** | −0.120*** | −0.121*** |
| | (0.014) | (0.014) | (0.014) | (0.017) | (0.017) | (0.017) |
| Observations | 7,371 | 7,371 | 7,371 | 9,637 | 9,637 | 9,637 |
| *R*-squared | 0.175 | 0.184 | 0.191 | 0.070 | 0.072 | 0.085 |

ADL = activities of daily living, BMI = body mass index, IADL = instrumental activities of daily living.
Notes: Other control variables include city and province, and year dummy variables. Significance level: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Standard errors, clustered by id and year, are in parentheses.
Source: Authors' calculations.

Table 3. **Additional Health Capacity to Work by Location of Residence and Education, Ages 65–69 Years (%)**

| | Male | Female |
|---|---|---|
| Urban | 34.7 | 27.9 |
| Rural | 19.2 | 17.8 |
| Educated | 34.5 | 29.6 |
| Less educated | 32.3 | 22.1 |

Note: Educated are those with high school level or higher.
Sources: Authors' calculations using the Cutler, Meara, and Richards-Shubik method.

women has much less, or even an insignificant, impact on the employment rate compared with their male counterparts.

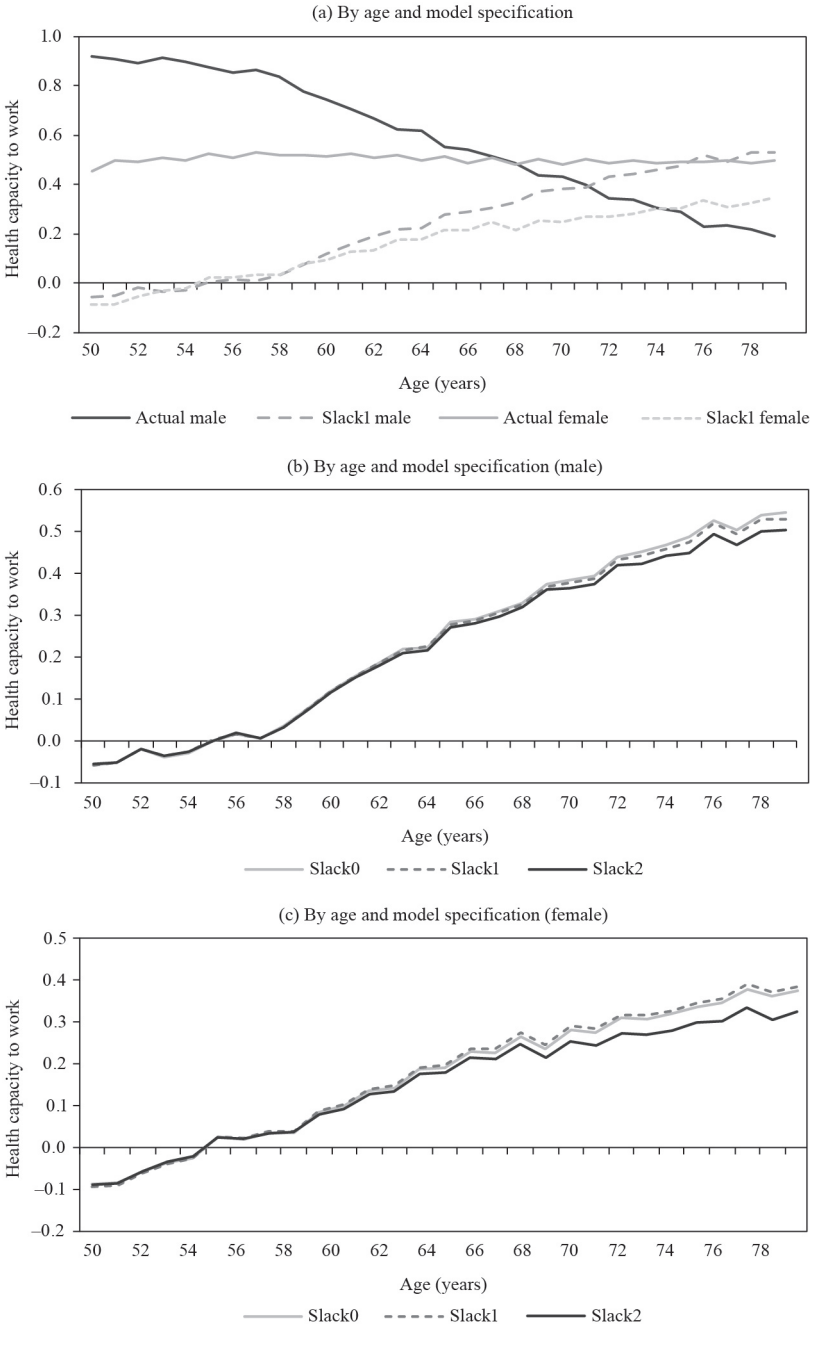
CES-D, ADL, and IADL show negative coefficients for all cases, suggesting that adverse health conditions tend to decrease the probability of working. Korean men who have some problems with IADL, such as preparing meals, are less likely to work by 4.9 percentage points than those who do not. The negative impact is much bigger for women who have some problems with IADL at 12.8 percentage points. Having ADL limitations decreases the probability to work by 30–40 percentage points for men, while the reduction is much less for women. Older people with severe cognitive impairment are more likely to stop working than those who have no cognitive ability problems, and the coefficient for women is slightly higher. Chronic heart disease, cancer, and arthritis symptoms are significant only for older women, while depression has a significant negative impact only for older men. The coefficients indicate that men with a tertiary school education are less likely to be employed than those with less than a secondary education. People with a spouse are more likely to work than their counterparts as well. Some estimated coefficients have the unexpected sign. For example, older men and women with drinking habits are more likely to work than those who do not drink alcohol, which might stem from a reverse causation problem.

## 2. Health Capacity to Work

Based on the estimated coefficients for those aged 50–59 years, we simulate the untapped HCW for people aged 60–79 years by a single year of age. The potential HCW, or the slack, is calculated as a gap between the actual and the predicted employment rate.

Figure 5 presents the actual and the predicted work capacities for Korean men and women by age (Table A3 of the Appendix). The slack based on the complete

Figure 5. **Health Capacity to Work**




Source: Authors' calculations.

specification (Model [2]) is the lowest, while the slack based on simpler models (Models [0] and [1]) are not very different from each other. We will report the slack based on Model (1) here. By and large, for all people aged 60–79 years, the capacity increases with age almost steadily. For men, the slack increases from 12.0 percentage points at age 60 to 28.5 percentage points at 65 and reaches 53.0 percentage points at age 79. The estimated total amount of potential HCW among men is about 1.46 million people, which accounts for about 30% of older Korean men aged 60–79 years. Considering that the total number of male workers aged 60–79 years in the Republic of Korea is 2.24 million, the male workforce aged 60–79 years would expand by 60% if all potential HCW could be realized. For women, the slack increases from 10.5 percentage points at age 60 to 23.7 percentage points at 65 and reaches almost 42.0 percentage points at age 79. The estimated total amount of potential HCW is about 1.34 million people, which accounts for about 25% of older Korean women aged 60–79 years. As the total number of female workers ages 60–79 in the Republic of Korea is 1.36 million, the female workforce aged 60–79 years would almost double if all potential HCW were realized. Thus, although the HCW is smaller for females than males, the percentage increase in workers due to improvements in health would be much bigger for women due to their lower employment rate.

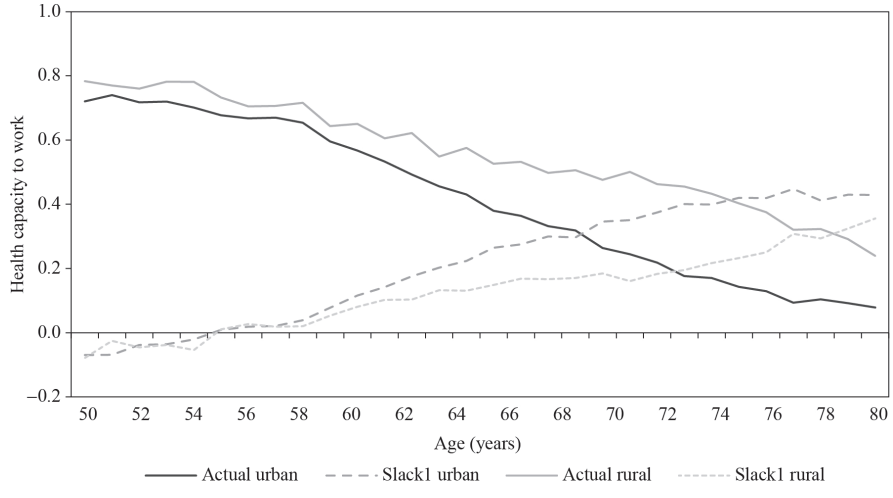
### 3. Health Capacity to Work for Heterogeneous Groups

This paper also analyzes the HCW by additional socioeconomic characteristics such as location of residence and educational attainment (Table A4 of the Appendix). Male workers, people with more education, and people living in urban areas have a larger HCW than their female, less educated, and rural counterparts, respectively. Similarly, employees have a larger HCW than self-employed people, and the gap between the two groups widens by age as well.

Why are older people not working although they can? Coile, Milligan, and Wise (2017) suggest that a generous pension scheme might discourage older adults from working more. This might be true for the majority of developed countries, as the employment rate drops dramatically around pension-eligible ages. The employment rates for older Korean men and women decline almost linearly between the ages of 60 and 79. This might be related to the fact that only one-third of older Koreans aged 65 years and above are currently receiving old-age pensions. The pension replacement rate of the Republic of Korea is also very low.

To understand the effect of pensions on employment as well as HCW, we estimate the HCW by place of residence in the Republic of Korea (Figure 6). The results suggest that the health gradient is still one of the most critical determinants for

Figure 6. **Health Capacity to Work by Place of Residence**




Source: Authors' calculations.

working. For both urban and rural areas, having poor SRH decreases the probability of working by about 40 percentage points compared to those who have excellent SRH. While the impairment of cognitive ability is only significant in urban residents, heart disease and depression have a bigger negative impact on rural residents.

While the female dummy variable has a negative sign in both urban and rural areas, the negative coefficient is almost twice as much for urban residents than rural residents. In addition, married people in urban areas are less likely to work, while married people in rural areas are more likely to work. Thus, while married women have a lower probability of working in urban areas, it is single women who have a lower probability of working in rural areas.

Urban residents tend to stop working much earlier than their rural counterparts, especially after age 57. On the other hand, the employment rates of rural residents decline quite smoothly for all age groups. This pattern is in stark contrast with other Western countries and Japan, where the employment rate drops quite rapidly around the pensionable age. Second, results show that older urban people have a higher HCW than their rural counterparts in terms of both magnitude and share of the labor force. That is, urban older people tend to retire earlier than their rural counterparts, although they can work longer in terms of their HCW, suggesting that health status is not a critical factor for working longer among older urban adults. Instead, this implies that older urban people may have other sources of income such as institutional pensions. Alternatively, older workers in urban areas might have been forced to stop working

due to widespread mandatory retirement practices in the formal sector.[9] Besides, the gap in HCW between rural and urban residents is larger among highly educated people. This suggests that human capital and productivity lead to differences between older rural and urban people in terms of working longer. Given that education programs for rural residents are of lower quality than those of their urban counterparts, the results might reflect current gaps in educational institutions across regions. All these findings generally point to the fact that the pension effect on retirement can vary substantially by region and country. The HCW can also result from many sources other than pension benefits, such as labor market rigidity and other labor market conditions, other old-age support systems such as savings and family transfers, and the productivity of older workers.

We have also conducted a few sensitivity analyses. For example, we changed the base age groups to 50–54 and the simulated age groups as well to see if the results are robust regardless of the change of the base and simulated groups. Although the slack shifts to the left or right depending on the starting age of the simulated age groups, these patterns are not sensitive to the choice of sample selection, suggesting that the CMR method's assumption about the relationship between health and employment is still valid, at least for the Republic of Korea.

## V. Conclusion and Policy Implications

When people live longer and healthier lives, a society can utilize their additional health capacity to strengthen the economic security of older people and sustain economic growth. People working longer also contributes to the soundness and sustainability of a country's pension and social security systems. The results of our analysis confirm that health is a significant determinant of older Koreans' decision to work. Furthermore, there is substantial additional HCW among older Koreans.

At the same time, substantial HCW does not automatically translate into substantial labor income. Older Koreans tend to have high labor force participation rates but low average productivity. The effect of low productivity dominates the impact of increased labor force participation in shaping their labor income (Lee and Ogawa 2011). Successive Korean governments have sought to mitigate the negative economic effects of population aging by encouraging older people to work longer. For example, raising the pensionable age might be expected to lead to labor market policies that

[9]Of course, other income can be savings or other asset income. However, relying on savings or asset income fails to explain the sudden drop in the employment rate around ages 58–59.

create good jobs for older people. However, the labor income of older people continues to be limited because they tend to work in low-productivity sectors. Therefore, it is necessary for policymakers to set clear goals for job training programs and integrate them with the old-age support system. Fully utilizing older people's HCW requires improving the structure of old-age employment to raise the productivity of older workers. There are currently few formal retraining programs for retirees in the Republic of Korea. As such, employment promotion policies for older persons should create more such programs and tailor them to the specific needs of older workers. The Republic of Korea suffers from the highest old-age poverty rate among OECD countries but has the lowest level of social welfare programs. It is thus urgent to strengthen the social safety net to combat old-age poverty as well.

Our results show that educated urban workers retire much earlier than rural workers. This is partly due to pension-benefits eligibility but also due to widespread mandatory retirement in the formal sector, which is more predominant in urban areas.[10] For example, a seniority-based wage system is still prevalent in the Republic of Korea's formal sector. Hence, reforming the wage system can kick off a transition from a seniority-based to a performance-based wage system and thus a more flexible labor market. One short-term option would be to strengthen the peak wage system, which gradually cuts the wages of older workers several years before retirement. In addition, educated urban housewives have a large HCW. Tapping this silver dividend requires a targeted policy that flexibly adjusts working careers and working hours to accommodate both women's lifestyle preferences and companies' needs. Currently, older educated housewives can join the labor market more easily because their children are self-sufficient. However, it is hoped that the use of more flexible employment strategies by companies can enable women to better reconcile their lifestyles with their working lives.

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[10]Our results also suggest that the effect of pensions on retirement varies substantially across countries. Therefore, we should interpret the CMR method results with caution when we apply this method to countries with underdeveloped pension systems.

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### Appendix

To view all appendixes, please refer to the supplementary materials that are available at: https://www.worldscientific.com/doi/suppl/10.1142/S0116110524400067.