Appendix for

"The evolution of age-friendly jobs in a rapidly ageing economy"

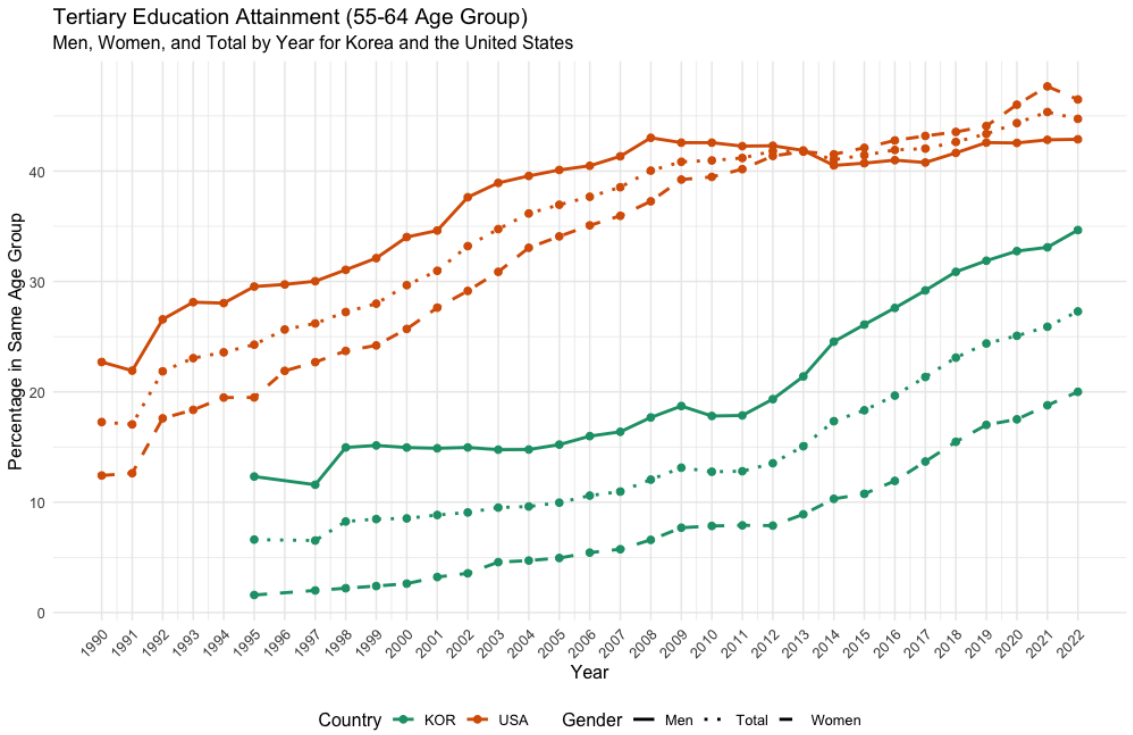
This appendix provides more information about the data, methods, and findings regarding our key research questions: the job characteristics of older workers in Korea, how they compare to those of younger workers, and documenting how Korea's labor market has adjusted to the changing demographics of the Korean population. We first document the job characteristics that older Koreans experience, relative to their younger counterparts and to the US, especially for the job amenities used in the definition of age-friendliness. Then we characterize the "age-friendliness" of Korean employment from 2000 to 2020 by applying the Age-Friendliness Index (AFI) developed by Acemoglu, Mühlbach and Scott (2022; hereafter AMS) to Korean occupational data.

Any attempt to classify all forms of paid employment into a few hundred occupations must involve some level of aggregation. "Occupation" may be defined more broadly (construction versus healthcare) or narrowly (doctor versus nurse). The AFI is based on 299 specific occupations, from age-friendly vocational counselors to cement workers (ranked as the most and least age-friendly, respectively, by AMS 2022). Each occupation includes a variety of specific jobs, each with its own bundle of tasks that may evolve over time. For example, "physician" is one of the 299 AFI-ranked occupations. This category inherently must average across the job attributes of primary care doctors, neurosurgeons using robotic surgery, and radiologists increasingly utilizing AI for image reading. Similarly, "nurse" subsumes registered nurse, licensed practical nurse, and the changing scope of practice for nurse practitioners. Because the gradations of occupational specificity may differ across economies and over time, creating such comparisons often requires some aggregation into occupations and occupational groups (e.g., 2-, 3-, or 4-digit specificity).

Note that the AFI by construction omits many characteristics that workers value, including wage, total hours, or fringe benefits. Given that health and pension benefits may matter more for older than younger employees, the omission of these benefits (in both the Maestas et al. estimates of willingness to pay for job amenities and the AMS application of those estimates for defining AFI) suggest caution in interpreting AFI as a sufficient statistic for work characteristics appealing to older workers.

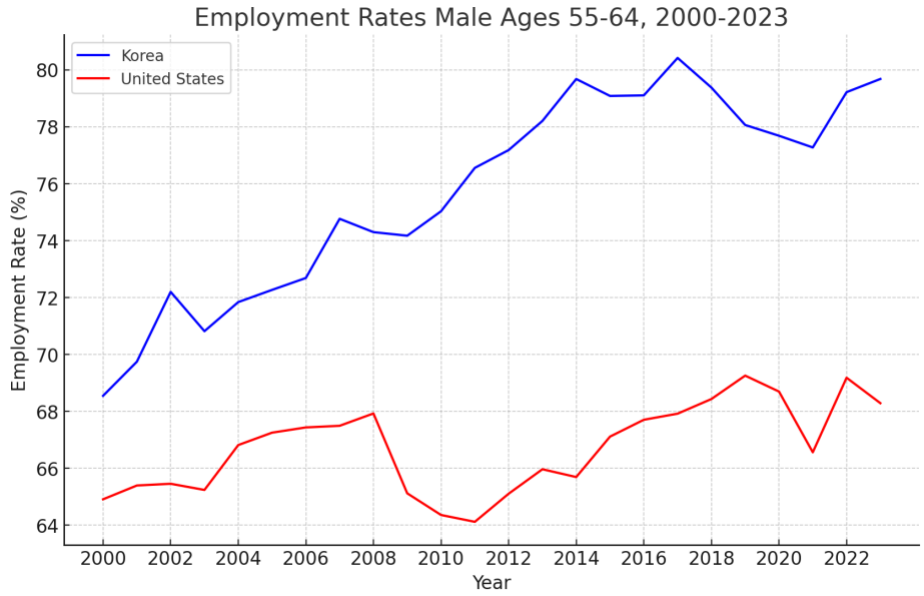
This appendix describes our methods and findings in more detail. The appendix organization parallels that of the paper itself, with demographic and employment background first, and then more information about the data, methods, results, and robustness analyses regarding the "age-friendliness" of Korean employment and the gender differences in "age-friendly" employment.

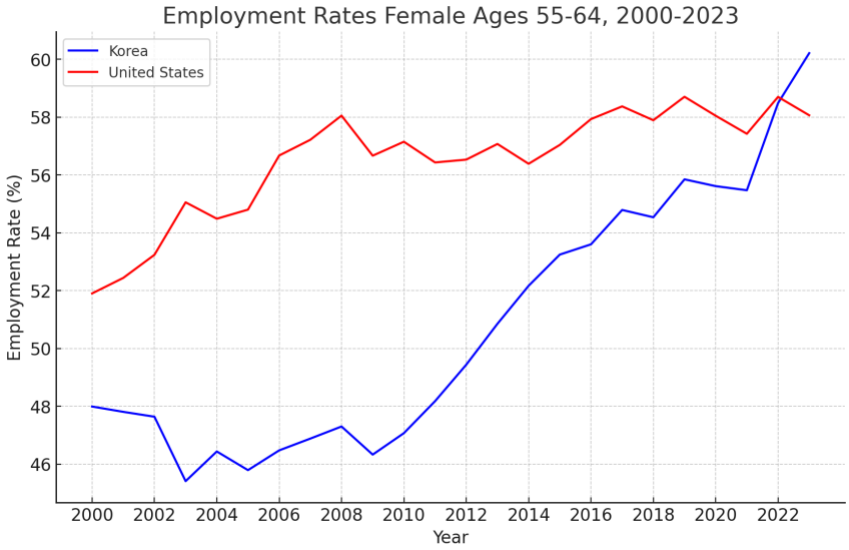
Appendix Figure 1. Human capital of older workers, Korea and the U.S.



Sources: OECD statistics.

Appendix Figure 2. Employment rates for individuals ages 55-64 in Korea and the U.S., for men, women, and overall, 2000-2023





Source: OECD statistics.

Job satisfaction and work amenities

Data from the Korean Working Conditions Survey (KWCS) in 2020 are used to describe working conditions for different Korean population subgroups and to compare working conditions between Korea and the U.S. using the 2018 American Working Conditions Survey (AWCS). To facilitate comparison, we used a crosswalk between SOC and KSCO and calculated the simple average of each amenity within the 2-digit SOC. Although the occ1990dd classification system was available for analysis, its application was limited by two key factors. First, the number of respondents for many occupations was too small to provide reliable estimates. Second, the survey did not fully cover all occupations in the occ1990dd

classification. While the 2010 version of occ1990dd includes 330 occupations, the survey data only contained responses for 193 occupations, leaving significant gaps in the dataset.

It is important to note that measures of job amenities are based on respondents' subjective perceptions rather than objectively verified data. Since the KWCS does not have a direct counterpart for the "make a positive impact on community/society" metric used by Maestas et al. (2018, 2023) and AMS, we proxy it with "feeling that one is doing useful work." Additionally, because employer-sponsored and self-funded training were not differentiated, we used overall on-the-job training instead.

In Table 1, figures have been adjusted to match the criteria in Table 1 of Maestas et al. (2023).

Definition of variables used to define job amenities from KWCS

The definitions for the specific job conditions and how they are measured in the KWCS 2020 are described below:

Set Own Schedule: The ability to determine one's working hours freely, with some restrictions.

Telecommuting: Experience of working from home, at least rarely.

Heavy Physical Activity: A work condition where involves physically strenuous or painful postures, at least half of the time

Mostly Sitting: A work condition where is spent in a seated position, at least three-quarters of the time

'Not fast paced': Based on reporting that 'working at a very fast pace' occurs 'rarely or never' in the KWCS question about how often the employee works 'at a very fast pace.' This is the best Korean match to the US question posed by Maestas et al. (2023): "How would you describe the pace of this job?" with two possible responses: "Fast-Paced" or "Relaxed." To enable a direct comparison, responses of "rarely" or "never" to the KWCS question about how often the employee works 'at a very fast pace' were considered equivalent to the "relaxed" response to the US question posed by Maestas et al. (2023).

Autonomy: The ability to independently choose or adjust at least one of the following: work speed, work methods, or task order**.**

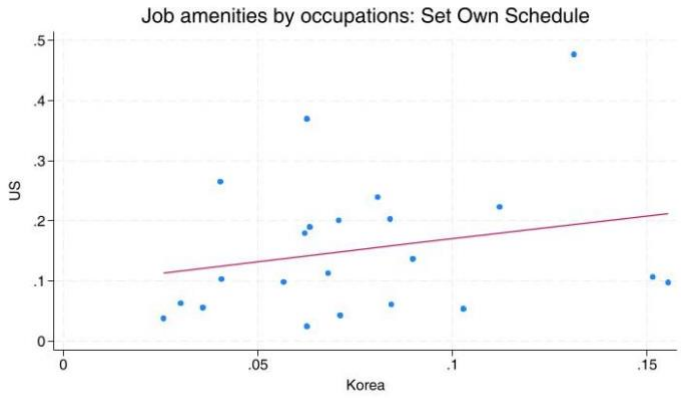
Work by Self: Not working in a group or team.

Training Opportunities: Having on-the-job or employer-provided training programs available to employees.

Sense of Usefulness: Feeling of doing useful work (measured as share who report 'mostly agree' or more)

The metrics used for comparing jobs between Korea and the U.S. differ in scale. Telecommuting and sense of usefulness are measured on a 5-point scale (ranging from always (5) to never (1)), whereas sitting, fast pace, and intense physical activity are assessed on a 7-point scale (always (7) to never (1)).

The correlation in prevalence of specific job amenities by occupation in Korea and the US (based on the KWCS 2020 and AWCS 2018, as shown in Table 2) are depicted in the figures below.


Job amenities by occupations: Set Own Schedule
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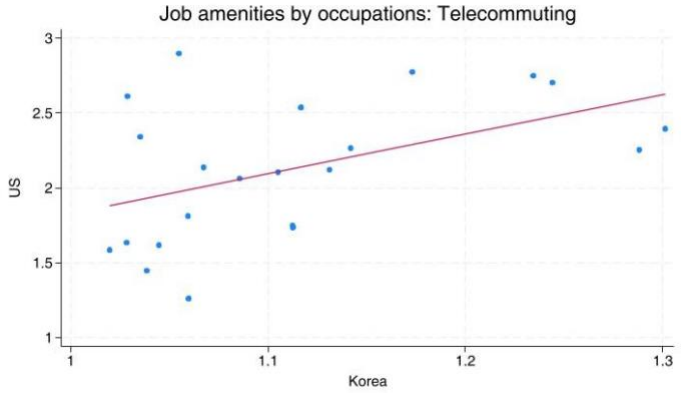
.15


Job amenities by occupations: Telecommuting
US
Korea
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2
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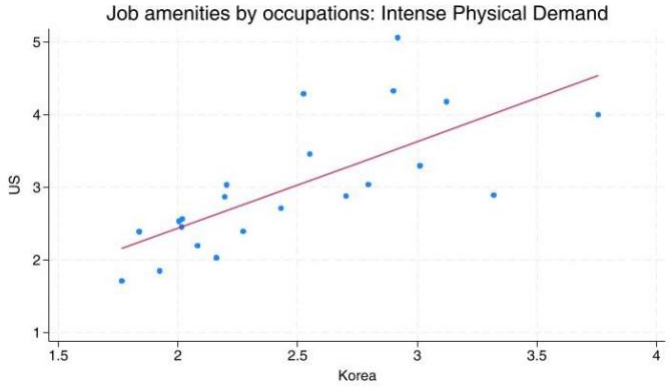
3
1
1.1
1.2
1.3


Job amenities by occupations: Intense Physical Demand
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Korea
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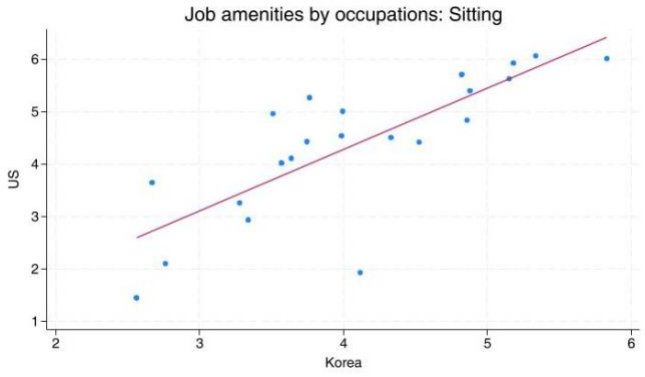
Job amenities by occupations: Sitting
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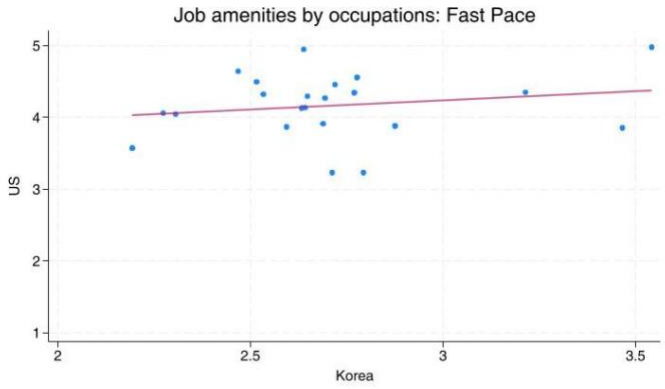
Job amenities by occupations: Fast Pace
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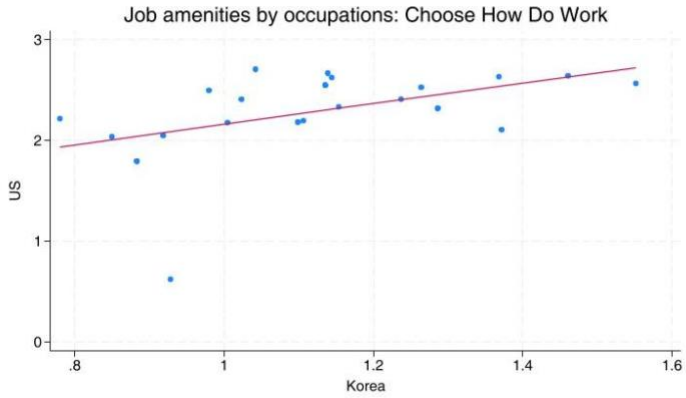
Job amenities by occupations: Choose How Do Work
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Korea
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1.2
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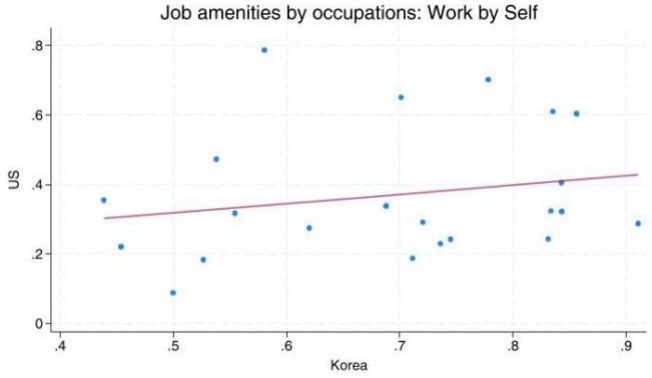
Job amenities by occupations: Work by Self
US
Korea
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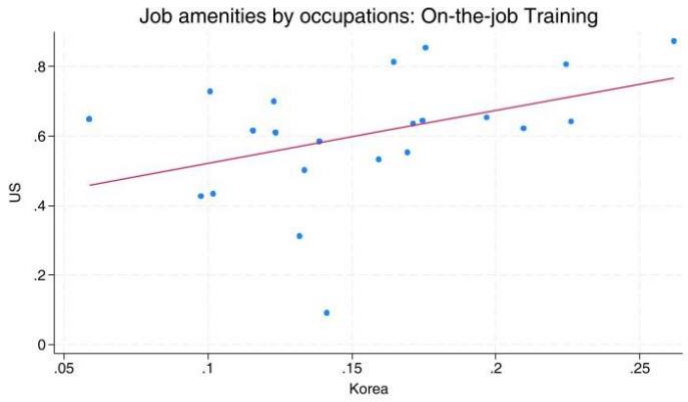
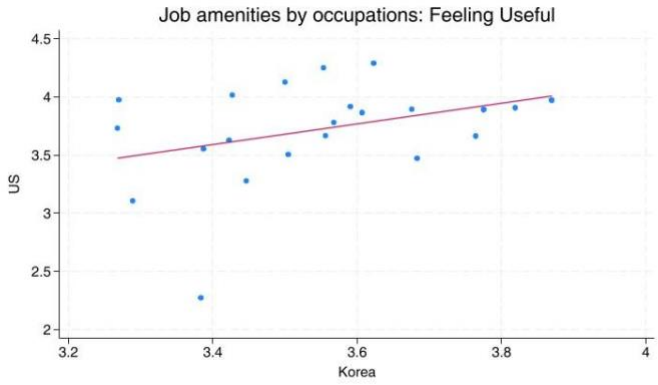




Methods for creating a consistent longitudinal series for Korean occupations and defining their age-friendliness index

This section of the appendix provides additional detail regarding the methods described in the paper.

Example table of crosswalk for occupational employment:

occ5	occ5_broad	occ6_broad	occ6	emp_occ5	emp_occ6
0121	012	111	1110	100	200
0122	012	111	1110		
0131	013	111	1110	100	
0132	013	111	1110		
0133	013	111	1110		
0210	021	112	1120	100	100
0220	022	120	1201	100	50
0220	022	131	1313		50

Example of linking back in time: Table number of 6th KSCO (2010) linked to 5th KSCO (2000):

count_unique	Freq.	Percent	Cum.
1	98	61.64	61.64
2	37	23.27	84.91
3	10	6.29	91.19
4	7	4.40	95.60
5	4	2.52	98.11
7	1	0.63	98.74
13	2	1.26	100.00
Total	159	100.00	

Linking forward in time from the 6th KSCO linked to the 7th KSCO (2020):

count_unique	Freq.	Percent	Cum.
1	146	95.42	95.42
2	5	3.27	98.69
3	2	1.31	100.00
Total	153	100.00	

The original **occ1990dd** classification consists of 330 occupational categories. However, the dataset provided by Acemoglu et al. (2022) contains only 299 categories, leaving 31 occupations unaccounted for. To address this discrepancy, we integrated the missing 31 categories into the dataset by merging them with existing occupational categories that are expected to have similar AFI scores. (The likely reason for this omission is the incomplete coverage of occupational information in O*NET, which may have resulted in the exclusion of certain occupations. Similarly, in Korea, approximately 10% of occupations face similar limitations, as not all job information is fully covered in available datasets.)

The average number of occ1990dds linked to each 6th KSCO occupation is 4.6, with a median of 4. Notably, 74% of KSCO occupations are linked to 6 or fewer occ1990dds.

Example of calculating kAFI based on US occ1990dd AFI:

occ6_unit	occ1990dd	afi	afi_unit
111	13	0.311	0.325
111	22	0.336	0.325
111	22	0.336	0.325
111	22	0.336	0.325
111	37	0.312	0.325
111	4	0.318	0.325

As this process by necessity utilized several different occupational classifications, the same occ6-occ1990dd pairs can appear more than one time.

Construction of occupational hourly wage

To construct hourly wage data for Korean occupations over our study period, we had to draw from several different sources as well. For our baseline in 2000, wage data at the 3-digit level was unavailable, so data from 2001 was used instead. Moreover, since wage data for 2001 and 2020 was not collected through the same survey, we used the Regional Employment Survey (RES) for 2020 and the Occupational Employment Statistics (OES) for 2001.

Because the OES classifies occupations based on the Korean Employment Classification of Occupations (KECO) rather than KSCO, it was necessary to establish a crosswalk between KECO-2001 and KSCO 6th revision. Although an official crosswalk table between KECO-2001 and KECO-2005 does not exist, we confirmed that the two classification systems are nearly identical after comparing their constituent occupational titles. The only difference was that the 'Agricultural Manager' category existed in 2001 but was removed in 2005. To address this, we linked 'Agricultural Manager' in KECO-2001 to 'Other Construction, Electrical, and Production Managers' based on KECO-2005.

We used the KECO-2005 to KECO-2007 crosswalk table and the KECO-2007 and KSCO 6th revision crosswalk table to construct the final crosswalk between KECO-2001 and KSCO 6th revision. Statistics Korea provides crosswalk tables for KECO-2007 and KSCO 6th revision and KECO-2005 to KECO-2007.

Applying the KECO-2001 to KSCO 6th revision crosswalk table to the OES raw data, we calculated the average wage for each 3-digit KSCO 6th revision category. Following the same method, we linked the KSCO 7th revision dataset to the KSCO 6th and KSCO 7th revision crosswalk table. We then calculated the average wage based on the 3-digit KSCO 7th revision classification.

Korean AFI in 2020

As a validation exercise, we did attempt to apply the AMS methods directly to Korean data to construct a Korean AFI using Korean descriptions of occupation-level tasks and job amenities. However, the definition vector of "age-friendliness" was still based the willingness-to-pay of older workers compared to younger workers in the U.S. (from Maestas et al. 2023), because we have not yet been able to collect Korea-specific data on willingness to pay for various job attributes.

The resulting Korean AFI should be used with caution since it is not a complete index for several reasons. First, the job description data was not available longitudinally. It was extracted from the website worknet in Korea which has job description data from various years (as they do not survey all aspects in every year). The data we use comes from 2018 to 2021. Hence, we compare it to the 2020 AFI we constructed for Korea based on the methods noted in the main text. Second, the definition of age-friendliness is not of Koreans. Third, the job description data was more robust for some cases than for others. For these reasons, we only use this as a robustness check to verify that there is a strong correlation between this

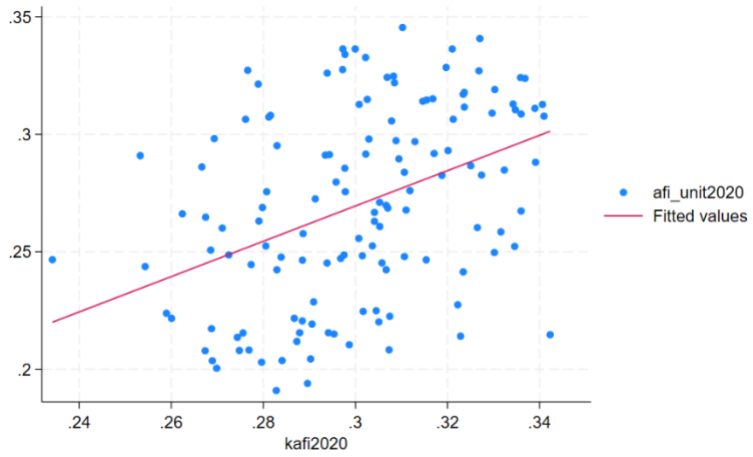
version of the Korean AFI and the primary one we use in the analyses, as shown in this descriptive regression.

AFI2020 in Korea and based on Korea worknet job descriptions and U.S. willingness-to-pay for job attributes

	(1) U.S.-based AFI
Korea worknet AFI2020	0.780***
	(0.000)
Constant	0.0360
	(0.413)
Observations	139
Adjusted R^2	0.16637
F	28.54

p-values in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

When comparing only the robust connections for the Korean AFI (68 cases), the coefficient increases from 0.75 to 0.86. However, the accuracy of the Korean AFI has not been fully verified.



Analysis with robust data

We performed a sensitivity analysis using what we term "robust data," which we define as data for Korean occupations meeting the following criteria:

1. Occupations linked to 5 or fewer occ1990dd categories, and
2. Occupations in the 6th KSCO linked to 5 or fewer categories in the 5th or 7th KSCO.

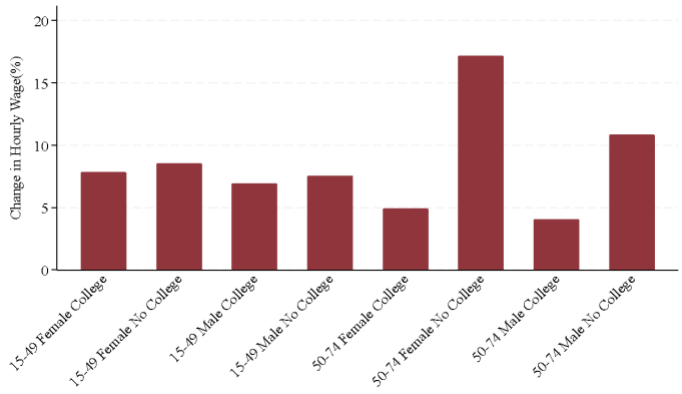
This robust dataset covers 47% of occupations. Re-running the correlation between AFI and share of older workers with this 'robust data' shows that the positive and significant association between the Korean AFI and the share of older workers remains and is stronger than when including all occupations (Table 3).

AFI and Share of Older Workers in Occupations in 2000, using 'robust data' 47% of occupations

	(1)	(2)	(3)	(4)	(5)
AFI	1.001***	0.995***	1.620***	1.385***	0.821*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.065)
Share of female		-0.0213	-0.00442	0.0882	-0.117*
		(0.746)	(0.938)	(0.195)	(0.093)
Share of college graduate			-0.220***	-0.298***	-0.0936
			(0.000)	(0.000)	(0.273)
Hourly wage				0.131***	0.0717
				(0.009)	(0.138)
Industry share					O
Constant	-0.0653	-0.0561	-0.141*	-0.191**	-1.138***
	(0.347)	(0.454)	(0.083)	(0.016)	(0.008)
Partial R2 of AFI	0.07215	0.07347	0.26122	0.31085	0.77539
Adj. R2	0.05787	0.04452	0.22604	0.26639	0.65524
N	67	67	67	67	67

p-values in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Percentage change in hourly wage, 2000-2020, by demographic group

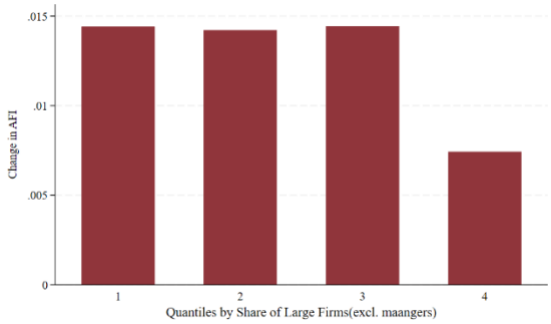


Robustness of large firm effects when excluding managerial occupations

As noted in the main text, both large corporations and managerial positions appear to play a role in the comparatively slow growth of AFI in Korea compared to the US. There is an interaction between large firm employment and managerial jobs. Analyzing employment by firm size and occupational AFI from 2004 (the first year for which we have the appropriate data) to 2020, we find that non-managerial employment grew significantly, increasing by 98.9% in large firms and 80.5% in SMEs, indicating that managerial positions have declined relative to the overall workforce. Overall, 16% of all managerial employees worked in large firms in 2004. This share increased rapidly, reaching 27% in 2020. The shift was driven by a 36.6% increase in the number of managerial employees in large firms, while SME managerial employment declined by 30.3% over the 16-year period.

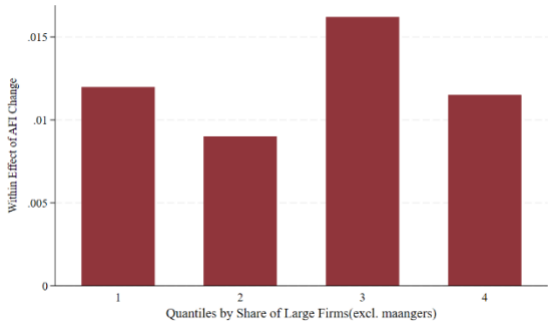
The share of managerial positions among employees in large firms (300+ employees) declined from 2.5% in 2004 to 1.7% in 2020, representing a 30.6% decrease. In small and medium-sized enterprises (SMEs), the decline was even steeper, falling from 3% to 1.2% over the same period—a 60% decrease, nearly twice the rate of large firms. A particularly notable trend is the 91.2% increase in the number of professionals in SMEs, highlighting a shift in workforce composition.

Change in AFI by large firm quartiles excluding managerial occupations:



Between effect of change in AFI by large firm quartiles when excluding managerial occupations:

Within effect of change in AFI by large firm quartiles when excluding managerial occupations:



Heterogeneity in age-friendly employment: Older workers and gender roles

Korean firms are often eager to replace older workers, who are typically viewed as less productive (Lee 2024). More research on the labor productivity of older workers in jobs of varying age-friendliness would be useful. For example, Saez et al. (2024)[1] analyze the loss of employment protection for Swedish workers over age 67, finding evidence of considerable "deadwood" labor: "unprofitable jobs that firms would like to terminate but cannot, because of employment protection legislation (EPL) and because entrenched older workers insist on staying put to reap rents" (p.1). The EPL in Sweden before age 67 resembles Korea's social norm and retirement age legislation protecting workers to age 60.[2] Korea's fiscally strained and financially modest pension support system appears to be functioning similarly, with the lower age of losing employment protection (60 vs. 67 in Sweden) related to Korea's rapid changes in human capital

[1] Saez, E., Schoefer, B., Seim, D., 2024. Deadwood Labor? The Effects of Eliminating Employment Protection for Older Workers. NBER working paper 31797. DOI 10.3386/w31797.

[2] Especially at the start of our study period when the human capital of older workers was relatively low, this protection to age 60 may have led to retention of low-productivity workers. Saez et al. (2024) describe this pattern as resulting in "a moderate boost to the length of the working life by extending the duration of, and hours in, the last jobs, albeit presumably by reducing firm profits and with potential equilibrium effects on the hiring of younger workers," equivalent to "shifting social insurance and retirement funding to employers" (p.4).

by cohort. Clearly, there is a need to study late-life labor productivity and find ways to improve it to make investing in workers' longer working lives also attractive to firms and other employers and avoid potential negative spillovers on younger and middle-aged workers' career trajectories (Lee and Chung 2023).

For Korea, we show that the proportion of women employees has increased in high-AFI-decile positions and decreased in low-AFI positions. Since the increase in the share of college graduates is more evenly distributed across AFI deciles than the female share, it is evident that in Korea age-friendly and female-friendly jobs overlap more than age-friendly and college-friendly job characteristics do (or that college-educated men have a wider spectrum of jobs to choose from in balancing their work and family lives, compared to their female counterparts).

Compared to other economies at similar stages of the demographic transition or per capita income, the change in gender roles in Korea appears to be less pronounced, relative to the substantial increase in the human capital of female workers. For example, Kim and Hahn (2022) find disparate employment and earnings impacts for men and women in Korea, with a larger "motherhood penalty" or "child penalty" than in other OECD economies.[3] Lee and Chung (2023) empirically examine the impacts of Korea raising the mandatory retirement age, finding that the adverse employment effect on middle-aged and young workers was stronger among female workers and those engaged in service industries.

Caregiving for children remains a key differentiating factor. As Stansbury et al. (2024) emphasize, children explain most of the employment gap between men and women in Korea. Occupations with more flexibility, including non-regular positions akin to the 'gig economy,' are often more compatible with caregiving. In this sense, the AFI could be rechristened as the "age- and caregiver-friendly" index. According to our analysis of data from the Economically Active Population Survey, Korea's gender gap in rates of non-regular employment (including self-employed, family workers, daily and temporary workers) has narrowed over the past two decades, but is still significant among college-educated women over age 30 (with the share of non-regular employees among women ten percentage points higher or more than that of men at each age between 30 and 70). Under these circumstances, it is observed that female employment responded more elastically to the increase in age-friendly jobs.

[3] Married couples face the same pressures as documented by Goldin (2021) for the US in earlier and recent cohorts: one parent accepts the "greedy job" with less time flexibility, and the other forfeits some earnings and career progression opportunities to work in a more caregiver-friendly position—often the mother. Some suggestive evidence supporting this comes from the low rate of Korean women in managerial positions compared to other OECD countries (OECD 2023). Women represented 15.1% of Korean managers in 2010, increasing to 20.9% by 2020, but still ranking lower than Turkey, Malaysia, or South Africa (OECD 2023). The female share is also low but increasing among Korean lawyers (11.0% in 2010 to 27.8% in 2020) and high-ranking officials (for grade 4 and above, 6.3% in 2010 to 17.8% in 2020, according to data from the Ministry of Gender Equality and Family in 2021, as reported by Kim et al. 2024, p.34).