

Cognitive Functioning among Older Adults in Japan and Other Selected Asian Countries: In Search of a Better Way to Remeasure Population Aging

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Japan is the oldest society in the world. It has the highest proportion of the population aged 65 and over, a demographic indicator that has been used by demographers for more than a century. One of the main objectives of this study is to apply a new indicator—the cognition-adjusted dependency ratio (CADR)—to remeasure the level of population aging from an innovative point of view. To compute this new index, we apply the mean age-group-specific immediate recall scores for Japan and four other Asian countries, and we compare the results with those derived from the United States and various developed nations in Europe. Our analysis shows that Japan’s pattern and level of age-related decline in cognitive functioning are highly comparable to those of many other developed nations, particularly in Continental Europe. Among the other Asian countries, Malaysia shows a pattern of change similar to countries in Southern Europe, although Malaysia has slightly lower scores than Southern Europe in all age groups. More importantly, these comparative results based on CADR are astonishingly different from the corresponding results obtained from conventional old-age dependency ratios. The Japanese case is the most salient example.

Keywords: cognition-adjusted dependency ratio, cognitive functioning, immediate word recall, population aging

JEL codes: J11, J14

I. Introduction

Since the second half of the 1960s, the tempo of world population growth has been gradually slowing down due to substantial fertility declines in various countries, both developed and developing. Population aging has become a worldwide phenomenon, attracting growing attention from researchers and policy makers particularly for its escalating economic and social costs (Sanderson and Scherbov 2010). The field of demography has increasingly recognized that while the 20th century was the century of “population explosion,” the 21st century is becoming the century of “population aging” (Hermalin 2003; Lutz, Sanderson, and Scherbov 2004; United Nations 2007; Clark, Ogawa, and Mason 2007; Fu and Hughes 2009; Uhlenberg 2009; Arifin and Ananta 2009; Tuljapurkar, Ogawa, and Gauthier 2010; Eggleston and Tuljapurkar 2010; Lee and Mason 2011; Park, Lee, and Mason 2012; Kendig, McDonald, and Piggott 2016).

At present, almost 60% of the world population inhabits Asia, making it the most populous region in the world. Also, the proportion of Asia’s population aged 65 and over in the world’s elderly population has been continuously rising since the end of World War II. In 1950 it was 44%, but it reached 57% by 2020 and is now projected to grow to 62% in 2050 (United Nations 2019).

In parallel with such rapid growth of its older population, Asia has also witnessed dramatic changes in its demographic landscape, particularly its population's age composition. Asia's total dependency ratio, which is expressed as the ratio of the number of dependents to the working-age population $\{[(0-14 \text{ years old}) + (65 \text{ years old and over})]/(15-64 \text{ years old})\}$, reached its peak value (0.81) in 1966, after which its projected long-term trend showed a U-shaped pattern reaching its trough value (0.47) in 2015. In addition, there have been substantial inter-country differences in the trends and levels of population aging within Asia in the past several decades (Mason 2001, Lee and Mason 2011, Ogawa et al. 2021).¹

To compare the burden of population aging across countries, we frequently use conventional demographic indicators such as the age dependency ratio, which is defined as the ratio of the number of elderly people to the working-age population $[(65 \text{ years old and over})/(15-64 \text{ years old})]$, and the index of aging, expressed as the ratio of the number of elderly persons to the young population $[(65 \text{ years old and over})/(0-14 \text{ years old})]$. Based on these commonly used demographic indicators, we characterize and rank how old countries are. Although these demographic indicators are readily available to researchers, one of their most serious limitations is that they are exclusively based on chronological age distributions. Because of this, they fail to provide a powerful base for deriving persuasive conclusions on the consequences of and possible responses to population aging. To cope with this major drawback, Skirbekk, Loichinger, and Weber (2012) recommend a new approach in which age variation in cognitive abilities among older persons is incorporated into a revised version of the conventional total dependency ratio, with a view to comparing the extent of aging across countries from an innovative standpoint. It is important to note that this new approach has become feasible primarily thanks to an increasing number of surveys collecting individual data on cognitive abilities among older persons in numerous countries, both developed and developing, particularly since the 1990s.

Among them, the Health and Retirement Study (HRS), a longitudinal survey of a representative sample of United States (US) citizens over the age of 50, is the most well-known and has served as a public resource for data on aging since 1990. The HRS has a number of sister studies in many countries all over the world. In recent

¹Apparently, such inter-country differences in the age-composition transformation have contributed to generating marked differences in the magnitude and timing of the "first demographic dividends," which have, in turn, facilitated a remarkable economic growth in various Asian countries. The economic "miracle" of East Asian economies between 1960 and 1997 is a salient example (Bloom and Williamson 1998).

years, such studies have been implemented in five Asian countries: Japan (the Japanese Study of Aging and Retirement or JSTAR), the People's Republic of China (PRC; the China Health and Retirement Longitudinal Study or CHARLS), India (the Longitudinal Ageing Study in India or LASI), Thailand (the Health, Aging, and Retirement in Thailand or HART), and Malaysia (the Malaysia Ageing and Retirement Survey or MARS).²

By drawing heavily on microlevel datasets gathered from these surveys, we compute age-specific cognitive abilities among adults aged 50 and over in each of these Asian countries, and then compare the differences in their cognitive performance. We also compare them with their counterparts in selected Western countries. In the second half of the paper, we examine, by applying microlevel data from the Asian surveys to the regression model, how and to what extent the cognitive abilities of older adults in each country are related to a host of demographic, socioeconomic, and biopsychological factors. Based on the computed results, we discuss both similarities and dissimilarities of the relationships between cognitive functioning and its covariates such as demographic, socioeconomic, and medical factors in the five Asian countries. Subsequently, we briefly discuss the likely future trends in older adults' cognitive abilities in these countries.

The paper is organized as follows. Section II discusses cognition measures and matters related to them to facilitate later on in the paper a variety of analyses on inter-country variations in cognitive functioning of older workers in the five selected Asian countries, the US, and a number of industrialized nations in Europe. To provide a solid base for conducting such analyses, Section III reviews several important earlier studies, which have examined numerous key factors linking the relationships between cognitive functioning and a host of demographic and socioeconomic factors. Section IV describes the data from the five Asian surveys mentioned earlier, which will be used in Section V to compute the mean age-group-specific immediate recall scores in the Asian countries. These scores will be compared to those for Europe and the US, as derived from an earlier study by Skirbekk, Loichinger, and Weber (2012). In Section VI, we relate the computed mean age-group-specific immediate recall score to population aging using the cognition-adjusted dependency ratio (CADR). In Section VII, we attempt to identify the factors associated with immediate recall

²Besides these five countries, the HRS was extended to the Republic of Korea (the Korean Longitudinal Study of Aging or KLoSA). Unfortunately, the immediate recall data gathered in KLoSA were not measured in a way comparable to those employed in this study. For this reason, we have excluded KLoSA from our study.

scores among the adults aged 50–79. Section VIII summarizes the main findings with a few policy implications.

II. Measuring Cognitive Functioning

Over the past few decades, rapid population aging worldwide has compelled several countries in Europe, Asia, and elsewhere to gradually postpone the mandatory retirement age to maintain financial solvency and sustainability of their public pension schemes (Clark and Ogawa 1992, Clark et al. 2008). At the same time, because cognition affects the capacity to acquire and use information, improving cognitive functioning at older ages has been adopted as a top public health priority in many countries to enable individuals to make good decisions and, ultimately, to remain independent and care for themselves longer (Maurer 2010). However, cognitive functioning of older workers can vary widely across countries, which can create large differences between them in the severity of various problems arising from aging (Skirbekk, Loichinger, and Weber 2012).

Due to the importance of cognition and cognitive variation among older adults, the HRS and its sister studies have made cognitive measurement a priority (Ofstedal, Fisher, and Herzog 2005; Weir, Lay, and Langa 2014). In general, the following activities are regarded as cognitive processes: thinking, knowing, remembering, judging, and problem-solving. Both fluid intelligence and crystallized intelligence are used in these cognitive activities (van Aken et al. 2016).

Fluid intelligence is the ability to use logic and solve problems in new or novel situations without resorting to pre-existing knowledge. Fluid intelligence plays a role in the creative process, and we often use it to handle nonverbal tasks such as mathematical problems and puzzles. On the other hand, crystallized intelligence is the ability to make use of information or knowledge previously acquired through education and experience. We usually employ crystallized intelligence when we encounter verbal tasks, such as reading comprehension or grammar. Crystallized intelligence is generally retained or even improved over time. By contrast, because fluid intelligence is rooted in physiological functioning, it typically peaks in young adulthood (approximately at an age of 25) and then steadily declines. Although fluid and crystallized intelligence represent two distinctly different sets of abilities, they often work jointly. For instance, when taking a test in mathematics, we use mathematical formulas and notations such as (+) and (–), which come from

crystallized intelligence as pieces of pre-existing knowledge, but also utilize fluid intelligence to develop strategies and derive solutions to accomplish the task.

In the HRS family of studies, different cognitive tests have been used to measure specific mental capacities. For instance, the capacities frequently tapped in previous research investigations are episodic memory, numeracy, orientation, attention, working memory, and verbal fluency.

One of the key domains of measuring cognition in an aging population is short-term memory, which is frequently evaluated using word recall tasks (Weir, Lay, and Langa 2014).³ The ability to recall words read from a randomly selected list of a certain number of given words generally declines with age.⁴ This ability is usually measured in two ways: (i) immediate word recall and (ii) delayed word recall. In immediate word recall, the respondent reads a list of 10 words and, after a very brief interval, recalls as many words as possible, not necessarily in order, within one minute. In delayed word recall, the respondent is asked to recall as many words as possible approximately five minutes after the immediate word recall task out of the same list the respondent had read for the immediate recall task.

The number of words and the length of time allowed for recalling the words can vary from survey to survey. For example, in the HRS, for both immediate and delayed recall tasks, a respondent reads one out of four possible lists of 10 words and then has two minutes to recall the words. Despite being given two minutes, a majority of HRS respondents do not make use of the second minute: 90% of the respondents used less than 49.2 seconds in the immediate recall task, and less than 50.4 seconds in the delayed recall task. Based on these results, Skirbekk, Loichinger, and Weber (2012) assert that recalling the words within one or two minutes does not affect the validity of inter-country comparative results in cognitive abilities.

In addition to short-term memory (e.g., immediate word recall and delayed word recall), a person's working memory is also used in the literature to measure variation in cognitive functioning. A common procedure for assessing working memory is a task called serial-7s, which is the repeated subtraction of sevens starting from 100. This activity involves numeric ability as well as the ability to attend to a task, thus falling into the category of fluid intelligence.

³Word recall measures are designed to capture the ability to remember and use relevant information while in the middle of an activity such as information processing. For this reason, word recall measures fall into the category of fluid intelligence.

⁴The ability to recall words is sensitive to brain changes that often occur at an early stage of Alzheimer's disease.

Apart from these measures of fluid intelligence, indicators of crystallized intelligence such as verbal fluency are also used to measure cognitive functioning. A well-known task in verbal fluency is naming animals—respondents list as many names of animals as they can in one minute.⁵

In view of the availability and comparability of HRS-type survey data among the five Asian countries, we confine our analysis of the cognitive functioning of older adults to immediate word recall scores.⁶ Another reason for this restriction is that an overwhelming majority of empirical studies conducted outside Asia thus far have been based on such scores, which means that we can compare our results with these studies (e.g., Weber et al. 2014; Bonsang, Skirbekk, and Staudinger 2017).

III. Earlier Studies Pertaining to Cognitive Functioning among Older Adults

The 20th century saw considerable growth in cognitive functioning in many countries. The factors that induced such cognitive improvements include greater exposure to cognitive stimulation through better education, improved living conditions, steady improvements in health, and declining average family size triggered by lower fertility and changing marriage values (Sundet, Borren, and Tambs 2008; Lynn 2009).

The study conducted by Skirbekk, Loichinger, and Weber (2012) examined inter-country age variation in cognitive functioning by measuring the immediate recall scores. The authors computed the mean age-group-specific immediate recall score using data from the HRS, the World Health Organization Study on global AGEing and adult health (SAGE), and the Survey of Health, Ageing and Retirement in Europe (SHARE). Caution should be exercised, however, in interpreting their results. For each 5-year age group, the mean value of the immediate recall score for older persons in a certain age group was computed from each relevant survey, but there are some

⁵Orientation is another measure of crystallized intelligence. Orientation is measured using a set of tests involving simple questions about the date and day of the week. The HRS contains additional items concerning the names of US presidents and vice-presidents.

⁶Immediate word recall has been shown to be important for a variety of outcomes, ranging from financial decision-making to the risk of developing dementia (Fein, McGillivray, and Finn 2007; Skirbekk, Loichinger, and Weber 2012). Moreover, technological advances and changes in working procedures imply that the importance of the ability to learn and remember is increasing (Machin and Van Reenen 1998). Employers are particularly interested in whether their employees are able to learn new work procedures and process new information (Munnell, Sass, and Soto 2006), which also suggests that employers view the ability to immediately recall information as advantageous to labor market performance.

differences in the way the respondents were tested by the interviewers. That is, respondents in as many as 18 countries were given one minute for recalling, but respondents in the US were allowed two minutes.⁷ Furthermore, the interviewers read out the 10 words to be recalled only once in all surveys except for SAGE, where interviewers read out the words three times before the respondents recalled the words. Despite these differences in the way the data on immediate word recall were collected, the computed results showed a statistically significant age-related decline in all the countries within the 50–84 age group.

In the face of rapid societal improvements over time, particularly during the 20th century, cognitive gender differences continue to be a source of scientific and political debate, and the magnitude, pattern, and explanation of these differences remain important research topics. By using data from SHARE, Weber et al. (2014) investigated gender differences in cognitive performance in the middle-aged and older populations across 13 European countries. They found that the magnitude of the differences varied systematically across cognitive tasks, birth cohorts, and geographical regions. In addition, both the living conditions and educational opportunities the individuals were exposed to during their formative years were related to increased gender differences favoring women in episodic memory (immediate word recall scores), decreased gender differences in the case of numeracy (arithmetic computation), and the elimination of differences in verbal fluency (animal naming). It is also interesting to note that their analysis of immediate word recall scores shows that although women in Northern Europe perform at a higher level than men across all birth cohorts, the pattern is different in Central and Southern Europe. In Central Europe, the female advantage is found only for birth cohorts born in 1932 or later, but not in earlier cohorts. In Southern Europe, there is even less of a female advantage, which gradually switches to a male advantage in earlier cohorts.

Weir, Lay, and Langa (2014) also examined gender inequality in cognition, by analyzing data from the PRC's CHARLS and India's LASI pilot survey, as well as from SAGE, using individual data derived from cognitive tests such as immediate word recall, orientation, serial-7s, and listing the names of animals. In both countries and in virtually all the cognitive tasks, men performed considerably better than women. In addition, the study found that despite some notable differences in survey samples and measures, a strong general association of cognition in older ages with education emerges as a potential explanation for the gender gaps and cohort

⁷In the HRS 92–94 version, 20 words were given to the respondents.

differences. They also found that the female disadvantage in cognition is greater in India than in the PRC, both before and after controlling for education.

It is generally considered that being married is associated with a healthier lifestyle and greater daily social interaction (Fuller 2010). These behaviors may improve cognitive reserve and reduce dementia (Kuiper et al. 2015). In this context, as briefly mentioned in footnote 4, the incidence of Alzheimer's disease (one of the subtypes of dementia) is closely connected with the ability to recall words.⁸ For this reason, it is highly conceivable that being married is positively related to the ability to perform short-term memory tasks such as immediate word recall. More importantly, a recent study carried out by Sommerlad et al. (2018), which is based on a systematic review and meta-analysis of 15 studies on the association between marital status and the risk of developing dementia, shows that being married is associated with a significantly smaller risk of dementia compared to lifelong single people.⁹ Hence, changing one's marital status may affect cognitive abilities throughout one's life.¹⁰

It is well known that old age tends to be related to a host of health risks such as cardiac infarction and cerebral hemorrhage (Slomski 2014). Furthermore, it is increasingly recognized that cognitive functioning tends to be a good predictor of future morbidity and mortality (Negash et al. 2011). Therefore, individuals with higher cognitive abilities are more likely to be healthier and live longer than those with low cognitive abilities. Cognitive abilities predict individual productivity better than any other observable individual characteristic, and they are increasingly relevant for labor market performance (Skirbekk, Loichinger, and Weber 2012). Moreover, this finding is applicable to many countries, both developed and developing, and in different settings, both urban and rural (Behrman, Ross, and Sabot 2008).

Over the past few decades, the number of seniors have been increasing in labor markets at an accelerating pace. Because certain cognitive abilities decline substantially at late adult ages, most studies previously conducted on older workers have focused on those aged 50 and over (Anderson and Craik 2000). A substantial fraction of these seniors can remain in the labor market for a long time, but how long they stay depends on how long they can retain high cognitive performance.

⁸Among dementia subtypes, Alzheimer's disease occupies the largest share in most countries in the world. In Japan, for example, approximately 70% of persons with dementia fall under the category of Alzheimer's disease.

⁹The following three Asian economies are included in this meta-analysis: Japan; Taipei, China; and the Republic of Korea.

¹⁰There is no significant difference in the risk of dementia among those currently married, divorced, or widowed.

Staying in the labor market could even improve cognitive performance. Using six waves of the HRS (1998–2008), Bonsang, Adam, and Perelman (2012) demonstrated that retirement negatively influences cognitive functioning for older Americans. This finding suggests that reforms aimed at promoting labor force participation at an older age may not only ensure the sustainability of social security systems but also create positive health externalities for older individuals. However, a study by de Grip et al. (2015) based on a Dutch survey dataset have found the opposite result. Using data from the Maastricht Aging Study (MAAS), they examined the relation between retirement and cognitive development in the Netherlands and showed that retirees experienced lower decline in cognitive flexibility than those who remained employed.¹¹

Primarily due to the growing availability of representative surveys on the cognitive functioning of elderly persons in different countries and regions, an increasing number of empirical studies on the determinants of cognitive performance among the elderly have been carried out in recent years. In addition, almost all of these surveys have used highly comparable questionnaires, thus making inter-country comparisons feasible. One salient example is the study carried out by Maharani and Tampubolon (2016). Using data from the 2006 round of the English Longitudinal Study of Ageing (ELSA) and the 2007 round of the Indonesian Family Life Survey Wave 4, the authors examined the associations between central obesity, as measured by waist circumference, and the cognition level in adults aged 50 and over in England and Indonesia. Conducting regression analysis, after controlling for some selected demographic, socioeconomic, and biomedical variables, they found that centrally obese respondents had lower cognition levels than non-centrally obese respondents in England, while the opposite was true for Indonesia.

Similarly, using data gathered in rural Central Java, LaFave and Thomas (2017) examined the relationship between the respondents' height and cognitive ability. By and large, taller workers earned more. In lower income settings, an adult's height is normally a marker of strength, which is rewarded in the labor market. Adult height is also a proxy for cognitive performance or other dimensions of human capital such as school quality, a proxy for health status, and a proxy for family background and genetic characteristics. Taking these observations into account, the authors conducted a regression analysis and showed that the respondents' cognitive abilities were significantly related to their height.

¹¹The authors also found that the decline in information processing speed after retirement particularly holds for those who are less educated.

By drawing on data derived from SHARE, Doblhammer, van den Berg, and Fritze (2013) examined cognitive functioning at the age of 60 and over. In their study, a total of 17,070 persons in 10 SHARE member countries were included in the analysis of several domains of cognitive functioning, which were linked to macroeconomic conditions during their birth year.¹² One of the main findings of this study was that economic conditions at birth significantly influenced cognitive functioning in late life in various domains. Another finding was that economic recessions adversely affected numeracy, verbal fluency, and recall abilities, as well as scores on omnibus cognitive indicators.

Furthermore, Bordone, Scherbov, and Steiber (2015) investigated if and why individuals aged 50 and over who were born into more recent cohorts performed better in terms of cognition than their counterparts of the same age born into earlier cohorts, a phenomenon called the “Flynn effect.” They used data from two waves of ELSA and the German Socio-Economic Panel (SOEP) surveys and showed that cognitive test scores of participants aged 50 and over in the later wave were higher than those of participants aged 50 and over in the earlier wave. In addition to identifying the Flynn effect based on the two cross-sectional waves, they pointed out that the reason why they used two waves was because a repeat cross-sectional design overcomes potential bias of retest effects. They also showed that although compositional changes of the older population in terms of education partly explain the Flynn effect, the increasing use of modern technology (i.e., computers and mobile phones) in the first decade of the 2000s also accounts for it.

IV. Description of Data Sources Used

In the rest of the paper, we aim to shed light on the age-specific pattern of cognitive abilities among older adults in Japan and four selected Asian countries, and then offer a statistical analysis of the demographic, biomedical, and socioeconomic factors associated with cognitive functioning in each country. To facilitate these quantitative analyses, we employ the following survey datasets: JSTAR for Japan, CHARLS for the PRC, LASI pilot survey for India, HART for Thailand, and MARS for Malaysia.

¹²The 10 countries included in the study are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and Switzerland.

A. Japanese Study of Aging and Retirement

JSTAR is a longitudinal, interdisciplinary survey that collects internationally comparable data on middle-aged and older adults. The JSTAR project commenced in 2007 and the survey has been implemented in 2-year intervals. Because JSTAR is a sister survey compatible with the HRS, a considerable proportion of the content included in the JSTAR questionnaire is comparable to the content in the other four Asian surveys, which were also modeled after the HRS. JSTAR's design and sample methodology are described elsewhere (Ichimura, Hashimoto, and Shimizutani 2009). The baseline sample consists of male and female respondents aged 50–75 from 10 Japanese municipalities.¹³ The respondents were randomly chosen from household registries in each of the 10 cities, towns, or villages. The sample size and the average response rate at the baseline were approximately 8,000 and 60%, respectively. JSTAR collects a wide range of variables, including economic, social, family, and health conditions of the sampled respondents. As for cognition-related variables, JSTAR gathers data on cognitive tasks such as short-term memory (both immediate and delayed word recall) and serial-7s.

Caution should be exercised in interpreting our results because we use data only from the first round of JSTAR from the following three groups: the five municipalities surveyed in 2007 (Takikawa, Sendai, Adachi, Kanazawa, and Shirakawa), the two municipalities added in 2009 (Naha and Tosu), and the three that joined the survey in 2011 (Chofu, Tondabayashi, and Hiroshima). This data treatment is chosen for the purpose of avoiding problems that arise from nonrandom dropout and retest-practice effects associated with cognitive tests in longitudinal surveys, including JSTAR (Thorvaldsson et al. 2006; Skirbekk, Bordone, and Weber 2014). As is the case with most internationally comparable surveys such as SHARE, the JSTAR respondents listened to 10 words read out by the interviewers and were given one minute each to recall them, both in the immediate and delayed word recall tasks.

B. China Health and Retirement Longitudinal Study

CHARLS is a nationally representative longitudinal survey of persons 45 years of age or older and their spouses, and includes assessments of the social, economic, and health circumstances of community residents in the PRC. CHARLS examines

¹³These 10 municipalities joined the JSTAR project at different points in time: Takikawa, Sendai, Adachi, Kanazawa, and Shirakawa joined in 2007; Naha and Tosu in 2009; and Tondabayashi, Hiroshima, and Chofu in 2011.

health and economic adjustments to the rapidly aging population of the PRC. The national baseline sample size is 10,287 households and 17,708 individuals, covering 150 counties in 28 provinces. The first national baseline wave was fielded from June 2011 to March 2012, followed by wave 2 in 2013 and wave 3 in 2015. Core CHARLS questionnaires include numerous sections dedicated to demographics, family structure and changes, health status and functioning, general health now and before the age of 16, physician-diagnosed chronic illnesses, lifestyle and health-related behaviors (smoking, drinking, and physical activities), subjective expectation of mortality, activities of daily living (ADLs), instrumental activities of daily living (IADLs), helpers, cognition testing (short-term memory task: two minutes to recall 10 words), depression (Center for Epidemiological Studies Depression Scale or CES-D), health care and insurance, work, retirement and pension, income and consumption, and assets (individual and household).

The interviewers conduct and carry equipment for measurements of health functioning and performance in respondents' households. These include the anthropometric measurements of height, weight, waist circumference, lower right leg length and arm length, lung capacity, grip strength, speed in repeated chair stand test, blood pressure, walking speed, and balance tests.

C. Longitudinal Ageing Study in India

In 2010, a LASI pilot survey was undertaken in four Indian states (Karnataka, Kerala, Punjab, and Rajasthan) on a targeted sample of 1,600 individuals aged 45 and older and their spouses. To capture regional variation, two northern states (Punjab and Rajasthan) and two southern states (Karnataka and Kerala) were included in the survey. Punjab is an example of an economically developed state, while Rajasthan is relatively poor, with very low female literacy, high fertility, and persisting gender disparities. Kerala, which is known for its relatively efficient health-care system, has undergone rapid social development and is included as a potential harbinger of how other Indian states might evolve.

The survey questionnaire consisted of sections such as the household roster, housing environment, household consumption, individual income of all household members, household real estate, household financial and non-financial assets, and household debts. In addition, the survey gathered various information concerning family and social network, social activities, psychosocial measures, life satisfaction, health conditions, and health-care utilization. In the section on mental health, the following cognitive task scores were collected: time orientation, short-term memory

(two minutes to recall 10 words), verbal fluency (animal naming), numeric ability (counting backwards from 20), and computation (serial-7s).

D. Health, Aging, and Retirement in Thailand

The primary objective of the HART project is to create a national longitudinal and household panel dataset on aging in Thailand.¹⁴ HART is a biannual household panel survey designed to provide panel data on the multidisciplinary dimensions of aging in older Thai adults, including (i) demographic characteristics, (ii) family and transfers, (iii) health and cognition, (iv) employment and retirement, (v) income, (vi) assets and debts, and (vii) life expectations and life satisfaction. Five thousand and six hundred households from five regions and Bangkok and its vicinity were sampled to represent national households. More concretely, 13 provinces were selected for forming a household panel in the baseline survey. In each household, one member aged 45 and over was selected as the respondent.¹⁵

The data collected from the national longitudinal survey in 2015 (wave 1) and 2016 (wave 2) are maintained in the data archive at the Intelligence and Information Center of the National Institute of Development Administration, Bangkok. The cognitive test consisted of three tasks: (i) word recall (immediate and delayed word recall tasks: two minutes to recall 10 words), (ii) numeracy (serial-7s), and (iii) data memory. Because cognitive test scores are available only in wave 2, we draw upon the individual data gleaned in wave 2 for our statistical analysis on the cognitive performance of older adults in Thailand.

E. Malaysia Ageing and Retirement Survey

MARS is a longitudinal study launched in 2018 which aims to produce nationally representative data on topics related to aging. MARS was motivated by the country's aging population and the importance of having such data to formulate and implement relevant policies. The baseline sample consists of households from all states in Malaysia, which were randomly selected based on Malaysia's 2010 Population and Housing Census. The Department of Statistics Malaysia (DOSM) selected the sample using a multistage sampling procedure. For each selected household, any member aged 40 and above who lived in the household most of the

¹⁴HART is harmonized with the HRS and its sister studies, including JSTAR, CHARLS, LASI, and MARS.

¹⁵For a more detailed description of HART, see: <https://g2aging.org/?section=study&studyid=44>.

time would be eligible to be selected as a respondent. Should there be more than one eligible member, a maximum of three oldest eligible members would be selected. The sample size of the first wave was 5,613 respondents with a response rate of 84%. These respondents will be interviewed every 2 years to measure changes in their health and economic and social circumstances.

MARS collects comprehensive information on various aspects of life and personal experiences covering six sections: (i) respondent background; (ii) family information and support; (iii) health and health-care utilization; (iv) work and employment; (v) income and consumption; and (vi) savings and assets. The cognitive abilities of respondents are measured in the health section where they are required to perform several tasks such as word recall (both immediate and delayed: two minutes to recall 10 words), serial-7s, time orientation, and semantic fluency (animal naming).

The word recall task was included in the questionnaires of all five Asian countries. We have carefully examined the inter-country comparability of the words asked in the immediate word recall tasks. Because all the countries developed their survey questionnaires through a close contact with the US HRS team and its international network, the words chosen for the immediate word recall test are not only very basic but also similar. Respondents were assigned a list of words from multiple word lists. In India's LASI pilot survey, for example, the interviewer randomly assigned one of the three lists each consisting of 10 words to a respondent. Interviewers for the PRC's CHARLS, Thailand's HART, and Malaysia's MARS randomly assigned one out of four lists each consisting of 10 words to a respondent.¹⁶

To overcome language barriers in India, the questionnaire was translated into four regional languages: Hindi, Kannada, Malayalam, and Punjabi. In Malaysia, the questionnaire was prepared in the following four languages: English, Malay, Chinese/Mandarin, and Tamil. It is conceivable that these additional adjustments incorporated in the questionnaires to overcome language barriers reduce some of the potential biases likely to emerge in inter-country comparative analyses of the immediate word recall task.

V. Inter-Country Comparison of Immediate Word Recall Scores

By closely following the computational steps taken by Skirbekk, Loichinger, and Weber (2012), we compute the mean age-group-specific immediate recall scores for

¹⁶Unlike the other Asian countries, Japan's JSTAR had only one list of 10 words for measuring immediate word recall. However, the 10 Japanese words selected for this task are very basic and commonly used not only in Japan but also elsewhere in Asia.

the five Asian countries by drawing on the microlevel data derived from JSTAR, CHARLS, LASI pilot survey, HART, and MARS. In addition, we quantitatively show where the cognitive abilities of the five Asian countries stand relative to developed Western countries, which have been computed by Skirbekk, Loichinger, and Weber (2012) using survey data from the HRS and SHARE.¹⁷ Caution should be exercised in interpreting the computed results because the time periods covered for the analyzed countries vary to a certain extent. For the Asian countries, the first wave of JSTAR was undertaken from 2007 to 2011, while CHARLS data were obtained in 2011–2012. Furthermore, HART was conducted in 2017, MARS in 2018, and the LASI pilot survey in 2010.¹⁸ In contrast, the HRS data were gathered in 2006–2007, while the SHARE datasets for various European countries were generated from the 2006–2007 round. Except for HART in 2017 and MARS in 2018, the datasets for JSTAR, CHARLS, LASI pilot survey, HRS, and SHARE employed in this study are relatively comparable in terms of the time period covered, circa 2010.

The study by Skirbekk, Loichinger, and Weber (2012) computed the immediate word recall scores for all the countries reported in this study, drawing on the microlevel survey data together with their sampling weights. To keep the Asian results compatible with those derived from the study by Skirbekk, Loichinger, and Weber (2012), we have attempted to use the RAND harmonized version of each country survey in Asia. One of the great advantages of using the RAND harmonized versions is that the sampling weights are computed for each data file.¹⁹ At the time of writing this paper, however, the RAND harmonized versions with sampling weights were available only for JSTAR, CHARLS, and the LASI pilot survey.

We have encountered another limitation with the harmonized JSTAR. As pointed out in footnote 13, the 10 survey sites did not join the harmonized JSTAR in the same year but in three different years. Moreover, to avoid problems arising from the nonrandom dropout and retest-practice effects associated with cognitive tests in longitudinal surveys, we have used only the immediate recall scores from the first round for each JSTAR survey site (cohort 1 residing in the five survey sites in 2007, cohort 2 living in the two sites in 2009, and cohort 3 in the three sites in 2011). For this

¹⁷We are grateful to Skirbekk and his associates for providing us with the data on immediate word recall scores used in their study published in the *Proceedings of the National Academy of Sciences of the United States of America* (PNAS) in 2012.

¹⁸At the time of writing this paper, we did not have access to the individual data gathered in main wave 1 and wave 2 of LASI conducted during 2016–2020. We plan to update our findings for India when a new dataset becomes available.

¹⁹Since 1989, the RAND Center for the Study of Aging has been producing harmonized versions of various national aging survey data files to facilitate international comparative research on aging.

reason, three different sets of computed sampling weights covering different numbers of survey sites exist. Technically, no single set of sampling weights can be computed for the entire sample combining the three different cohorts. Hence, in this study, we do not use the sampling weights available in the harmonized JSTAR.²⁰ Despite this limitation, we still use the harmonized JSTAR data file (without sampling weights) for computation since the JSTAR dataset was carefully cleaned by the country team who, in collaboration with RAND, conducted a consistency check. For this reason, we assume that various types of data entry errors and unreasonable outliers have been expunged before the datasets became available for public use.

With MARS and HART, we have not been able to obtain information on sampling weights to retain the comparability of the computed results. In the case of MARS, the Social Wellbeing Research Centre of the University of Malaya is currently collaborating with the RAND Center to rearrange the survey data file to be in line with RAND's harmonized version, and their work is expected to be completed by the end of 2021. Furthermore, in their preliminary computations, they have found that there is only a very small difference between weighted and unweighted results, which seems to indicate that the use of sampling weights may not be critically important. Thailand's HART has not started to compute its sampling weights.

Thus, in the rest of the paper, we will employ as the base for our computation the harmonized versions of the LASI pilot survey, CHARLS, and JSTAR. In addition, we will use the original MARS and HART to analyze Malaysia and Thailand, respectively.

Figure 1 compares the mean age-group-specific immediate recall scores²¹ for the five Asian countries, the US, and three European regions.²² Clearly, the mean age-group-specific immediate recall scores continuously decline with age in virtually all the countries and regions.²³ For the sake of clear exposition, we have plotted the results in Figure 1 using a solid line for the countries computed from the harmonized data files, and a dotted line for the remaining countries computed without sampling weights.

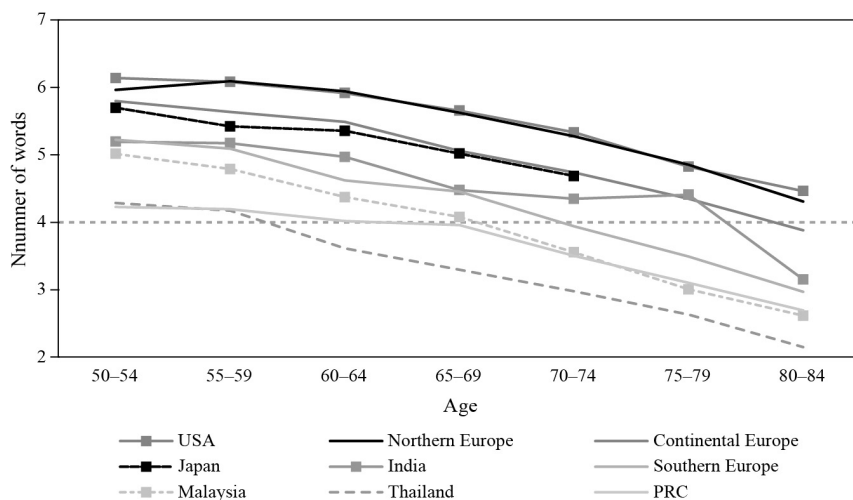
²⁰We have compared the results for the immediate recall scores, calculated with and without sampling weights for each of the three cohorts. The computed results show virtually the same for each cohort, which seems to indicate that our analytical results are fairly comparable whether or not we use sampling weights. The plotted results for the three cohorts are available from the authors upon request.

²¹The scores are expressed in terms of the number of words recalled, ranging from 0 to 10.

²²The SHARE data were used for the following three European regions: Northern Europe (Denmark, Ireland, and Sweden), Continental Europe (Austria, Belgium, Czech Republic, France, Germany, the Netherlands, Poland, and Switzerland), and Southern Europe (Greece, Italy, and Spain). The three European groups of economies were set up by Skirbekk, Loichinger, and Weber (2012), who also added England to the Northern Europe group, using data collected by ELSA.

²³In the case of the Northern European countries, the immediate recall score increased slightly from the 50–54 age group to the 55–59 age group.

Figure 1. Mean Age-Group-Specific Immediate Recall Scores in Selected Economies, circa 2010



PRC = People's Republic of China, USA = United States.

Note: "Northern Europe" includes Denmark, England, Ireland, and Sweden; "Continental Europe" comprises Austria, Belgium, Czech Republic, France, Germany, the Netherlands, Poland, and Switzerland; and "Southern Europe" covers Greece, Italy, and Spain.

Sources: Skirbekk, Vegard, Elke Loichinger, and Daniela Weber. 2012. "Variation in Cognitive Functioning as a Refined Approach to Comparing Aging across Countries." *Proceedings of the National Academy of Sciences of the United States of America* 109 (3): 770-74; and authors' calculations based on data from the following: (i) Japanese Study of Aging and Retirement of the Research Institute of Economy, Trade and Industry (RIETI), Hitotsubashi University, Japan, and The University of Tokyo, Japan; (ii) China Health and Retirement Longitudinal Study of the National School of Development of Peking University, Beijing; (iii) the pilot portion of the Longitudinal Ageing Study in India of the Harvard T.H. Chan School of Public Health, Boston, the International Institute for Population Sciences, Mumbai, and the University of Southern California, Los Angeles; (iv) Malaysia Ageing and Retirement Survey of the Social Wellbeing Research Centre of the University of Malaya, Kuala Lumpur; and (v) Health, Aging, and Retirement in Thailand of the Center for Aging Society Research/Research Center of the National Institute of Development Administration, Bangkok.

Figure 1 reveals a few interesting results. First, the US has the highest score for the 50-54 age group (6.1 words recalled out of 10), followed by the Northern European group (six words). Both the US and the Northern European group show a similar declining pattern with age in almost all age groups except for 50-54 and 80-84. Second, immediate recall age trajectories for Continental European countries and Japan are fairly comparable.²⁴ Furthermore, though not displayed in Figure 1, Japan's trajectory of change in the age-group-specific immediate recall scores is

²⁴JSTAR covers subjects aged 50-75. Because the age group 75-79 includes only those JSTAR respondents who are 75 years old, we have excluded this group from the analysis due to its skewed distribution.

between the Netherlands and France—Japan’s scores are slightly lower than those for the Netherlands but are consistently higher than those for France by a considerable margin.

Among the five Asian countries, Japan’s age-group-specific immediate recall scores are the highest in all groups until the 70–74 age group. Note that India’s score (4.5 words) for the 75–79 age group is higher than the corresponding value for the Continental European countries. This result needs to be interpreted with great caution. The total number of observations in India’s LASI pilot survey used for calculating the age-group-specific immediate recall scores is 1,007, but the number of observations for the 75–79 age group is only 65.²⁵ For this reason, the reliability of India’s score for those aged 75–79 is open to question.²⁶

The age-group-specific immediate recall scores for the Southern European group show a pattern of change similar to that for Malaysia, although Malaysia has slightly lower scores than Southern Europe in all age groups. Furthermore, Thailand exhibits a declining pattern in age-group-specific immediate recall scores and has the lowest scores among the five Asian countries in the 60–64 age group and older.

Attention should be drawn to the pattern of change in the PRC’s age-group-specific immediate recall scores. In the age groups 50–54 and 55–59, the PRC’s scores are marginally lower than those for Thailand, but in the remaining age groups, the PRC has substantially higher scores than Thailand. Moreover, the PRC overtakes Malaysia at ages 75–79.

In Figure 1, we have also drawn a horizontal dotted line at score 4 to facilitate an interesting discussion. Let us briefly turn our attention to Thailand and Continental Europe. In the case of Thailand, the average score for the 60–64 age group plunges below four words, which is a result obtained by those aged 80–84 in Continental Europe. Although the age difference amounts to approximately 20 years, the cognitive performances of these two groups are at the same level (four words). This suggests a huge difference in cognitive functioning between Thailand and the countries in Continental Europe. Such inter-country differences in cognitive abilities are likely to constitute a crucial and decisive drawback in the future to the transfer of new digitalized technologies and innovative production methods from advanced countries with higher cognition levels to the countries with lower cognition. More importantly,

²⁵The number of observations for India’s age group 80–84 is only 32.

²⁶The cohorts that are presently 50 years and older in India have grown up during a period of widespread poverty and high mortality and, as a result, the population has been positively selected in terms of cognitive performance at a more advanced age (Skirbekk, Loichinger, and Weber 2012). We plan to substantiate the validity of this view once we gain access to data from waves 1 and 2 of LASI (2016–2020).

in view of the slow process of cohort replacement, those countries whose seniors already have higher cognitive levels today are very likely to continue to be at an advantage for many decades to come. Thus, the legacy of low cognition among the older populations of today's developing countries will put them at a disadvantage for a very long time (Skirbekk, Loichinger, and Weber 2012; Weir, Lay, and Langa 2014).

VI. Introducing Cognitive Performance into the Measurement of Population Aging

In this section, we relate the computed mean age-group-specific immediate recall score to the context of population aging. For this purpose, we draw upon a new indicator that focuses on cognition and demographic change: the cognition-adjusted dependency ratio, which was proposed by Skirbekk, Loichinger, and Weber (2012).

The formula for CADR is expressed as follows:

$$\text{CADR} = \frac{|\{x \in P \mid (m_x < 5) \wedge (\text{age}_x \geq 50)\}|}{|\{x \in P \mid (15 \leq \text{age}_x < 50)\} \cup \{(m_x \geq 5) \wedge (\text{age}_x \geq 50)\}|},$$

where m_x represents the memory score of person x , age_x represents the age of person x , while P stands for the population. To compute CADR, we have applied the mean age-group-specific immediate recall scores for Japan and other countries in Asia, as well as in the US and Europe, to the relevant age-composition data derived from the United Nations (UN) population projection prepared in 2019.²⁷ This formula implies that if a country has a low value of CADR, then it is effectively “younger,” since it has a lower share of seniors with poor cognitive performance.

The calculated results are displayed in Table 1.²⁸ Although Japan's CADR value (0.22) is higher than the corresponding values for the US and Northern Europe (Denmark, England, Ireland, and Sweden), Japan's dependency ratio adjusted by age-specific cognitive scores is fairly comparable to that (0.18) of Continental Europe (Austria, Belgium, Czech Republic, France, Germany, the Netherlands, Poland, and

²⁷Because CADRs have already been computed based on the data derived from the 2009 UN population projection for the year 2005 for many European countries by Skirbekk, Loichinger, and Weber (2012), we have applied the 2005 age-composition data gleaned from the 2019 UN population projection to all the Asian countries except Japan to facilitate inter-country comparisons. In the case of Japan, because of the unique survey setup of JSTAR (2007–2011) described in Section V, we have applied the 2010 age composition.

²⁸As mentioned earlier, data for age groups 75–79 and 80–84 are not available in JSTAR. To calculate CADR, however, cognitive scores for these two old-age groups are required. For this purpose, we have conducted a linear extrapolation based on the data for those aged 50–74, and the linearity has been confirmed by comparing the extrapolated values with the observed values for other countries.

Table 1. **International Comparison of Cognition-Adjusted Dependency Ratio Scores, circa 2010**

Economy	CADR Score
United States	0.10
Northern Europe (Denmark, England, Ireland, and Sweden)	0.12
Continental Europe (Austria, Belgium, Czech Republic, France, Germany, the Netherlands, Poland, and Switzerland)	0.18
Southern Europe (Greece, Italy, and Spain)	0.32
<i>Asia</i>	
Japan	0.22
India	0.10
People's Republic of China	0.20
Thailand	0.21
Malaysia	0.12

CADR = Cognition-adjusted dependency ratio.

Sources: Skirbekk, Vegard, Elke Loichinger, and Daniela Weber. 2012. "Variation in Cognitive Functioning as a Refined Approach to Comparing Aging across Countries." *Proceedings of the National Academy of Sciences of the United States of America* 109 (3): 770–74; and authors' calculations based on data from the following: (i) Japanese Study of Aging and Retirement of the Research Institute of Economy, Trade and Industry, Hitotsubashi University, Japan, and The University of Tokyo, Japan; (ii) China Health and Retirement Longitudinal Study of the National School of Development of Peking University, Beijing; (iii) the pilot portion of the Longitudinal Ageing Study in India of the Harvard T.H. Chan School of Public Health, Boston, the International Institute for Population Sciences, Mumbai, and the University of Southern California, Los Angeles; (iv) Malaysia Ageing and Retirement Survey of the Social Wellbeing Research Centre of the University of Malaya, Kuala Lumpur; and (v) Health, Aging, and Retirement in Thailand of the Center for Aging Society Research/Research Center of the National Institute of Development Administration, Bangkok.

Switzerland), and is considerably lower than that (0.32) of Southern Europe (Greece, Italy, and Spain).

More importantly, these comparative results based on the CADRs are astonishingly different from those shown in Table 2, which reports the conventional age-composition indicators such as old-age dependency ratios and age dependency ratios for various countries, both developed and developing. Among the countries listed in Table 2, Japan's population is by far the oldest, but based on the CADRs listed in Table 1, Japan's is fairly close to the medium level observed among the European countries. This finding seems to justify the UN's recent efforts to raise awareness regarding the urgent need for remeasuring population aging in both developed and developing nations with a view to formulating effective policies for coping with aging.²⁹

²⁹For instance, the United Nations Population Division organized, in collaboration with the Institute for Applied System Analysis, Laxenburg, an expert group meeting called "Measuring Population Aging: Bridging Research and Policy" in Bangkok on February 25–26, 2019.

Table 2. Inter-Country Comparison of Selected Age-Composition Indices

Region or Country	Year	Total Dependency Ratio	Age Dependency Ratio
<i>Northern America</i>			
United States	2010	49.7	19.4
<i>Northern Europe</i>			
Denmark	2010	52.9	25.5
United Kingdom	2010	51.7	25.1
Ireland	2010	46.6	16.1
Sweden	2010	53.2	27.9
<i>Continental Europe</i>			
Austria	2010	48.2	26.4
Belgium	2010	52.0	26.4
Czech Republic	2010	42.2	22.0
France	2010	54.6	26.1
Germany	2010	51.8	31.2
The Netherlands	2010	49.2	23.0
Poland	2010	40.2	18.9
Switzerland	2010	47.0	24.8
<i>Southern Europe</i>			
Greece	2010	49.9	27.5
Italy	2010	52.7	31.3
Spain	2010	46.7	25.2
<i>Asia</i>			
India	2010	56.3	8.0
People's Republic of China	2010	35.6	11.4
Japan	2010	55.9	35.1
Malaysia	2010	49.0	7.4
Thailand	2010	39.0	12.4

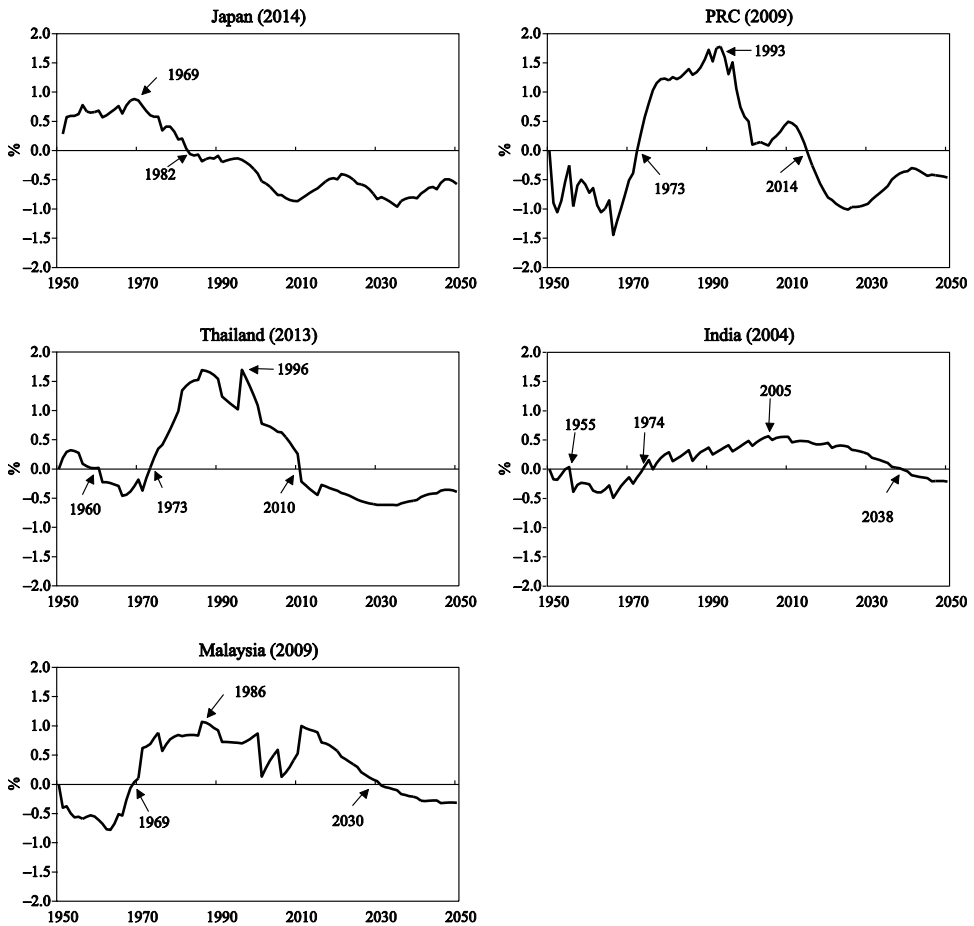
Source: Authors' calculations based on the data from the United Nations. 2019. *World Population Prospects: The 2019 Revision*. New York: United Nations.

Furthermore, in Table 1, Japan's CADR (0.22) is the highest among the five Asian countries, followed by Thailand (0.21) and the PRC (0.20). Because the PRC and Thailand have recently passed the first demographic dividend stage,³⁰ as illustrated in Figure 2, their aging process will be accelerating in the future, so their CADR values will also be swiftly rising in the years ahead.

In contrast, both Malaysia and India have a considerably younger age composition than the other three Asian countries, as reported in Table 2. Moreover,

³⁰For a more detailed description of the first demographic dividend, see Ogawa et al. (2021, 44–52).

Figure 2. Comparison of the Temporal Change in the Magnitude of the First Demographic Dividend



PRC = People's Republic of China.

Note: Each year enclosed in parentheses represents the survey year in which the data of per capita labor income and consumption for each country were gathered.

Source: Adapted from Figure 9 in Ogawa, Naohiro, Norma Mansor, Sang-Hyop Lee, Michael Abrigo, and Tahir Aris. 2021. "Population Aging and the Three Demographic Dividends in Asia." *Asian Development Review* 38 (1): 32–67.

as depicted in Figure 2, Malaysia and India are still enjoying the benefits of the first demographic dividend. Depending on their future fertility trends, their CADR values may vary greatly in the future. For instance, assuming the UN's low-fertility-variant population projection, Malaysia's CADR will be higher than Japan's current level by the mid-2060s.

VII. Factors Associated with Cognitive Functioning among Older Adults in the Five Asian Countries

In this section, we attempt to identify the factors associated with immediate recall scores among the adults aged 50–79 who are included in recent aging surveys in the five Asian countries by running a linear regression.

Before going any further, caution should be exercised with regard to our empirical analysis. In our regressions, the dependent variable representing immediate recall scores and a few explanatory variables such as education and work status have a problem of causal ordering. However, we are not able to resolve this endogeneity issue due to the absence of powerful instrumental variables in the datasets available to us.³¹ Thus, the regression results presented in this section primarily indicate associations between the dependent variable and the explanatory variables that cannot be interpreted in terms of causal effects. Nevertheless, our statistical analysis can be used to see whether the relationships between the immediate recall scores among the respondents and their individual attributes that have been discovered in various Western countries can also be confirmed in the context of the five selected Asian countries.

Let us first look at the computational results derived from the harmonized JSTAR (without sampling weights) in relative detail. As shown at the bottom of Table 3, the total number of observations is 4,873. The dependent variable is the number of words recalled by the respondent immediately after 10 words were read out by the interviewer. Except for the respondents' height, all other explanatory variables are dummy variables, with the dagger notation (†) representing the reference group. In this

³¹In our regression model, the issue of causal ordering between the dependent variable, cognitive performance, and some explanatory variables, such as education and work status, needs to be properly addressed. In the past, numerous studies have been undertaken which shed light on the relationships between cognitive functioning (measured in terms of immediately recalled words) and a host of other variables (demographic, socioeconomic, cultural, psychosocial, biomedical, etc.). However, most of these studies have not addressed the issue of potential endogeneity bias in their estimations, primarily because of the unavailability of appropriate instrumental variables. The issue of causal ordering has been solved successfully only in a very limited number of studies, including a study by Atalay, Barret, and Staneva (2019) and another by Schneeweis, Skirbekk, and Winter-Ebmer (2014). These studies successfully addressed the issue of causal ordering by drawing heavily on powerful instrumental variables created based on the variation caused by major policy reforms. Although we have, in the hope of addressing the issue of endogeneity, attempted to identify appropriate instrumental variables by going through various datasets available in the five Asian countries, our attempts have met no success at the time of revising our paper. Thus, following many earlier studies on this research topic, we confine ourselves in this study to examining the association between individuals' cognitive performance and their demographic and socioeconomic backgrounds. The issue of endogeneity remains to be addressed in our future work.

Table 3. Regression Analysis of Immediate Recall Scores among Those Aged 50 and Over in Japan

(Dependent Variable = Immediate Recall Score)					
Explanatory Variable	Coefficient	t-value	Explanatory Variable	Coefficient	t-value
<i>Age</i>			<i>Self-rated health status</i>		
50–54	0.262	3.44***	Excellent	0.179	2.29**
55–59	0.060	0.89	Very good	0.122	1.61
60–64 [†]	—	—	Good	0.105	1.46
65–69	–0.236	–3.46***	Fair [†]	—	—
70–74	–0.499	–6.91***	Poor	–0.255	–1.58
<i>Sex</i>			<i>CES-D (20 items)</i>		
Man	–0.569	–7.99***	≥16	–0.215	–1.56
Woman [†]	—	—	<16 [†]	—	—
<i>Marital status</i>			<i>IADLs (sum)</i>		
Currently married [†]	—	—	Height	0.555	1.33
Widowed	0.013	0.16	<i>Survey cohort</i>		
Divorced/separated	–0.169	–1.48	cohort 1 (5 cities) [†]	—	—
Single	–0.354	–3.02***	cohort 2 (2 cities)	–0.098	–1.68*
<i>Work status</i>			cohort 3 (3 cities)		
Working	–0.017	–0.33	<i>Intercept</i>	3.626	5.20***
Not working [†]	—	—			
<i>Education</i>					
Junior high school [†]	—	—			
Senior high school	0.416	7.37***			
Junior college	0.575	7.34***			
University or higher	0.748	9.59***			

CES-D = Center for Epidemiological Studies Depression Scale, IADLs = instrumental activities of daily living.

Notes: [†] denotes the reference group. Adjusted *R*-squared = 0.102. Number of observations = 4,873. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively.

Source: Authors' estimates based on data from the Japanese Study of Aging and Retirement of the Research Institute of Economy, Trade and Industry, Hitotsubashi University, Japan, and The University of Tokyo, Japan.

regression, we introduced the following 10 explanatory variables: age groups (50–54, 55–59, 60–64[†], 65–69, and 70–74), sex (man, woman[†]), marital status (currently married[†], widowed, divorced/separated, and single), work status (working, not working[†]), education (junior high school[†], senior high school, junior college, and university or higher), self-rated health status (excellent, very good, good, fair[†], and poor), CES-D (≥16, <16[†]), IADLs, height (centimeters), and survey cohorts (cohort 1[†] consisting of those residing in Takikawa, Sendai, Adachi, Kanazawa, and Shirakawa in 2007, cohort 2 comprising those living in Naha and Tosu in 2009, and cohort 3 consisting of those residing in Tondabayashi, Hiroshima[†], and Chofu in 2011).

The respondents' age and education have been incorporated in this regression to capture the effect of two types of intelligence on cognitive functioning. Fluid intelligence refers to the ability to reason and think flexibly, while crystallized intelligence refers to the accumulation of knowledge, facts, and skills throughout life (Cattell 1978). The explanatory variable, age, is expected to capture the change in fluid intelligence, which peaks approximately at an age of 25. Because the respondents included in the regression are 50 years or older, the estimated coefficients are expected to have negative signs. The other explanatory variable (educational attainment) is intended to capture the effect of education on crystallized intelligence, which is based on facts and rooted in experiences. As we age and accumulate new knowledge and understanding, crystallized intelligence becomes stronger. More importantly, because education can also improve learning techniques such as memorization skills, education helps improve performance in fluid intelligence even in the case of immediate word recall. Therefore, since fluid abilities are improved by crystallized intelligence to a substantial degree, we expect the estimated coefficient for education to have a positive sign. In addition, we can anticipate that the higher the level of education the larger the estimated coefficient will be.

As discussed in Section III, the magnitude, pattern, and explanation of cognitive gender differences remain important research topics. As demonstrated in a SHARE-based study undertaken by Weber et al. (2014), the magnitude of the gender differences in cognitive performance in middle-aged and older populations across 13 European countries varies systematically across cognitive tasks, birth cohorts, and geographical regions. Bonsang, Skirbekk, and Staudinger (2017) have also found that both living conditions and educational opportunities to which individuals are exposed during their formative years are related to increased gender differences, favoring women in immediate word recall scores. Whether these findings based on the European data are applicable to Japan and other Asian countries will be examined later in this study.

As for the other explanatory variables, the health-related variables such as self-rated health status, CES-D,³² and IADLs³³ are expected to be associated with cognitive performance. Moreover, a respondent without a spouse is likely to be left alone without anybody to communicate with, which may weaken his or her cognitive

³²Scores on the CES-D range from 0 to 60, where higher scores suggest a greater presence of depression symptoms. A score of 16 or higher is interpreted as indicating a risk for depression.

³³In JSTAR, the respondents were asked 15 questions pertaining to IADLs, and the variable's score, which ranges from 0 to 15 (IADLs sum), represents the number of activities that the respondent has no difficulty performing, such as shopping, preparing meals, housekeeping, managing finances, taking responsibility for having medication in correct dosages at the right time, etc.

functioning. Similarly, whether the respondent holds a job is likely to affect his or her level of life satisfaction and career development, both of which may affect cognitive performance.

The respondent's height has been incorporated in the regression because adult height is closely related to childhood nutritional condition which, in turn, affects cognitive functioning and other dimensions of human capital, such as school ability (Weir, Lay, and Langa 2014; LaFave and Thomas 2017).

We have also included in the regression a set of explanatory variables representing survey cohorts, which differ significantly in terms of the level of urbanization of the areas where the respondents live and their lifestyles. It is quite conceivable that, because a considerable proportion of the respondents included in cohort 3 live in wealthy urban areas such as Chofu in Tokyo, this cohort is more likely to be exposed to modern technologies, such as the Internet and computers, than their counterparts in cohort 1.³⁴ It is plausible that those who often use such modern technologies, by doing so, stimulate their crystallized intelligence (Bordone, Scherbov, and Steiber 2015). For these reasons, we expect that modern technologies will be more significantly associated with the cognitive score in cohort 3 than in cohort 1.

Table 3 shows the estimated results derived from the JSTAR dataset. Except for work status and height, all explanatory variables introduced in the regression are statistically significant, with the coefficients having expected signs.

As expected, the cognitive abilities of Japanese older adults are negatively associated with age. It is important to observe that education is positively related to immediate recall scores—the higher the educational level, the better the cognitive performance. Another important finding is that the respondent's own health evaluation (self-related health status) and physical limitations (IADLs) are also positively associated with the immediate recall score. Moreover, women show a considerably higher cognitive score than men, which is comparable to the pattern widely seen in the Northern and Central European regions. Those who are currently married have higher cognitive abilities than those who have never been married. In view of the rising prevalence of lifetime singlehood in Japan over the past few decades, this variable may play an increasingly important role in the future. Where respondents live also plays a role in cognitive performance—the coefficient for cohort 3, which includes a considerable number of respondents who live in relatively wealthy residential areas, is not only statistically significant but also positive, which agrees with our *a-priori* expectation.

³⁴For example, Shirakawa Town, which is included in cohort 1, is predominantly rural.

Let us now compare these JSTAR-based regression results with those estimated based on CHARLS, the LASI pilot survey, HART, and MARS. The results based on the PRC's CHARLS in Table 4 show that the coefficients of all the explanatory variables, except for marital status and work status, are statistically significant with theoretically expected signs. Compared to JSTAR, the coefficients for age, sex, education, and self-rated health status are statistically significant for both datasets with the theoretically expected signs, while marital status is statistically significant only for Japan. However, unlike in Japan, both height (childhood nutritional conditions) and CES-D (representing the level of depression) yielded statistically significant results in the case of the People's Republic of China.

Table 5 displays the regression results based on India's LASI pilot survey data. As mentioned, the number of observations in this dataset is relatively small—only 832 observations, which casts some doubt on the reliability of some of the estimated results. For instance, age, sex, work status, and CES-D are not statistically significant. However, education is a statistically significant predictor at the 1% significance level. It is also worth noting that Punjab, which is the most developed state among the four Indian states included in the pilot, exhibits a considerably higher cognitive performance.

Table 6 presents the regression results estimated from Thailand's HART dataset. Age, sex, marital status, education, and CES-D are significant predictors with theoretically expected signs. Due to the paucity of data, however, we could not incorporate the explanatory variables representing self-rated health status and IADLs. All provinces except for Surin have higher cognitive abilities than Bangkok (reference group). This result is rather unexpected, and we do not have a reasonably good explanation at hand.

Table 7 shows the regression results based on Malaysia's MARS data. All categories of the explanatory variables are statistically significant. As expected, cognitive functioning decreases as age increases. In addition, the estimated coefficients for sex, marital status, education, depression signs,³⁵ IADLs, and work status are statistically significant. Work status, unlike in other Asian countries, has a positive coefficient.³⁶

³⁵The depression symptom score is constructed using 17 negative and positive statements related to a respondent's experienced psychological well-being. The response scale for positive statements is inversely converted. The total score was calculated as the aggregate for all 17 statements. The total scores thus range from 17 to 85, with the scores in the top 15th percentile (44 or higher) interpreted as indicating a higher risk of depression (≥ 44 , < 44).

³⁶Although the Malaysian survey data indicate that many of those still working are in the agriculture sector, it is not clear why this contributes to increasing their cognitive functioning.

Table 4. Regression Analysis of Immediate Recall Scores among Those Aged 50 and Over in the People's Republic of China

(Dependent Variable = Immediate Recall Score)					
Explanatory Variable	Coefficient	<i>t</i> -value	Explanatory Variable	Coefficient	<i>t</i> -value
<i>Age</i>			<i>Self-rated health status</i>		
50–54	0.059	0.79	Very good	0.250	2.47***
55–59	0.070	1.18	Good	0.136	1.79*
60–64 [†]	—	—	Fair	0.116	2.15***
65–69	–0.049	–0.43	Poor [†]	—	—
70–74	–0.598	–7.73***	Very poor	–0.209	–2.08**
75–79	–0.923	–9.78***	<i>CES-D (10 items)</i>		
<i>Sex</i>			≥10	–0.402	–7.98***
Man	–0.137	–2.07**	< 10 [†]	—	—
Woman [†]	—	—	<i>Height</i>		
<i>Marital status</i>			<i>Region</i>		
Currently married [†]	—	—	Urban community [†]	—	—
Partnered	0.328	1.02	Rural	–0.244	–3.70***
Widowed	0.024	0.33	<i>Intercept</i>		
Divorced/separated	0.194	1.39		0.182	0.33
Single	–0.320	–1.25	<i>Work status</i>		
<i>Work status</i>			Working	–0.105	–1.52
Working	–0.105	–1.52	Not working [†]	—	—
Not working [†]	—	—	<i>Education</i>		
<i>Education</i>			Less than lower secondary [†]	—	—
Less than lower secondary [†]	—	—	Upper secondary and vocational	0.819	10.79***
Upper secondary and vocational	0.819	10.79***	Tertiary	1.545	7.21***
Tertiary	1.545	7.21***			

CES-D = Center for Epidemiological Studies Depression Scale.

Notes: [†] denotes the reference group. Adjusted *R*-squared = 0.136. Number of observations = 8,738. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively.

Source: Authors' estimates based on data from the China Health and Retirement Longitudinal Study of the National School of Development of Peking University, Beijing; see <http://charls.pku.edu.cn/index/en.html> (accessed 5 August 2020).

Another significant finding is the link between the respondent's health and cognitive ability, whereby poor self-rated health and higher signs of depression relate negatively to immediate recall scores. Nutrition, as represented by the respondent's height, is also seen to play an important role in cognitive functioning. We also observe that the coefficient for the more urbanized states, such as Kuala Lumpur, Pulau Pinang, and Perak, are positive and statistically significant. Better cognitive ability in these states may be attributed to greater exposure and utilization of technology in the subjects' daily lives.

Table 5. Regression Analysis of Immediate Recall Scores among Those Aged 50 and Over in India

(Dependent Variable = Immediate Recall Score)					
Explanatory Variable	Coefficient	<i>t</i> -value	Explanatory Variable	Coefficient	<i>t</i> -value
<i>Age</i>			<i>Self-rated health status</i>		
50–54	0.114	0.63	Excellent	0.285	0.61
55–59	0.161	0.84	Very good	0.424	1.70*
60–64 [†]	—	—	Good	0.171	0.79
65–69	–0.230	–1.01	Fair [†]	—	—
70–74	–0.183	–0.66	Poor	–0.604	–1.58
75–79	–0.328	–1	<i>CES-D (8 items)</i>		
<i>Sex</i>			≥8	–0.257	–1.84*
Man	–0.012	–0.06	< 8 [†]	—	—
Woman [†]	—	—	<i>Height</i>		
<i>Marital status</i>			<i>State</i>		
Currently married [†]	—	—	Punjab [†]	—	—
Widowed	–0.326	–1.69*	Rajasthan	–0.563	–2.98***
Divorced/separated	0.082	0.20	Kerala	–0.718	–3.93***
Single	–0.036	–0.07	Karnataka	–0.879	–4.26***
<i>Work status</i>			<i>Intercept</i>		
Working	–0.015	–0.10		2.593	1.72*
Not working [†]	—	—			
<i>Education</i>					
Junior high school [†]	—	—			
Senior high school	0.682	4.12***			
Junior college	1.247	4.22***			
University or higher	1.333	4.12***			

CES-D = Center for Epidemiological Studies Depression Scale.

Notes: [†] denotes the reference group. Adjusted *R*-squared = 0.126. Number of observations = 832. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively.

Source: Authors' estimates based on data from the Longitudinal Ageing Study in India of the Harvard T.H. Chan School of Public Health, Boston, the International Institute for Population Sciences, Mumbai, and the University of Southern California, Los Angeles; see <https://g2aging.org/downloads> (accessed 5 August 2020).

Several points of interest emerge from the foregoing discussions on the regression results for the five Asian countries. First, in all five Asian countries, the cognitive abilities of older adults decline with age. Second, education is highly and positively associated with immediate recall scores. Third, health condition is positively related with cognitive performance, and height is positively linked to better cognitive abilities, which implies that nutritional condition in childhood plays an important role in developing cognitive functioning at a later stage.

Fourth, those who are currently married have higher cognitive abilities than those who have never been married. In view of the recent gradual shift from universal

Table 6. Regression Analysis of Immediate Recall Scores among Those Aged 50 and Over in Thailand

(Dependent Variable = Immediate Recall Score)					
Explanatory Variable	Coefficient	t-value	Explanatory Variable	Coefficient	t-value
<i>Age</i>			<i>CES-D (20 items)</i>		
50–54	0.485	3.58***	≥16	–0.760	–2.94***
55–59	0.393	3.13***	< 16†	—	—
60–64†	—	—	<i>Height</i>		
65–69	–0.281	–2.25**	<i>State</i>		
70–74	–0.652	–4.88***	Bangkok†	—	—
75–79	–0.931	–6.90***	Samut Prakan	0.901	3.12***
<i>Sex</i>			Nonthaburi	0.062	0.10
Man	–0.231	–2.31**	Pathum Thani	0.558	1.61
Woman†	—	—	Sing Buri	0.845	3.49***
<i>Marital status</i>			Chanthaburi	0.973	4.05***
Currently married†	—	—	Surin	–0.161	–0.62
Widowed	–0.025	–0.25	Khon Kaen	0.948	4.05***
Divorced/separated	0.235	1.28	Chiang Mai	1.250	5.29***
Single	–0.397	–2.35**	Uttaradit	0.737	2.64***
<i>Work status</i>			Phetchabun	0.576	2.45**
Working	0.054	0.060	Krabi	0.477	1.72*
Not working†	—	—	Songkhla	1.119	4.83***
<i>Education</i>			<i>Intercept</i>	1.663	1.91*
No formal education†	—	—			
P ₁ –P ₆	1.041	5.76***			
M ₁ –M ₆	1.661	8.14***			
First year college or higher	2.295	7.21***			

CES-D = Center for Epidemiological Studies Depression Scale, M = secondary education, and P = primary education.

Notes: † denotes the reference group. Adjusted R-squared = 0.170. Number of observations = 2,264. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively.

Source: Authors' estimates based on data from the Health, Aging, and Retirement in Thailand of the Center for Aging Society Research/Research Center of the National Institute of Development Administration, Bangkok.

marriage to lifetime singlehood in Japan and other Asian countries, policy makers and researchers should pay more attention to Asia's changing marriage patterns in the years to come, particularly from a standpoint of cognitive performance among older adults.

Fifth, women show considerably higher cognitive scores than men. Nevertheless, to gain further insights into Asia's gender differences in cognition, we plotted male and female age-specific immediate recall scores for the five Asian countries in Figure 3. Although our regression results have uniformly indicated that women have higher

Table 7. Regression Analysis of Immediate Recall Scores among Those Aged 50 and Over in Malaysia

(Dependent Variable = Immediate Recall Score)					
Explanatory Variable	Coefficient	t-value	Explanatory Variable	Coefficient	t-value
<i>Age</i>			<i>Depression symptom score</i>		
50–54	0.307	3.51***	≥44	–0.229	–2.83***
55–59	0.272	3.21***	<44 [†]	—	—
60–64 [†]	—	—	<i>IADLs (sum)</i>	0.113	7.46***
65–69	–0.178	–1.91*	<i>Height</i>	0.017	3.87***
70–74	–0.478	–4.39***	<i>State</i>		
75–79	–0.788	–5.66***	Johor [†]	—	—
<i>Sex</i>			Kedah	–0.195	–1.52
Man	–0.602	–7.41***	Kelantan	–0.053	–0.39
Woman [†]	—	—	Kuala Lumpur	1.028	5.42***
<i>Marital status</i>			Melaka	–0.436	–1.88*
Currently married [†]	—	—	Negeri Sembilan	–0.334	–1.93*
Widowed	–0.050	–0.60	Pahang	–0.309	–2.36**
Divorced/separated	–0.176	–1.06	Perak	0.513	4.17***
Single	–0.270	–1.71*	Perlis	–0.154	–0.44
<i>Work status</i>			Pulau Pinang	0.358	2.22**
Working	0.140	2.01*	Sabah	–0.008	–0.07
Not working [†]	—	—	Sarawak	–0.55	–4.53***
<i>Education</i>			Selangor	0.165	1.45
No schooling [†]	—	—	Terengganu	–0.299	–1.99**
Primary	0.426	4.64***	<i>Intercept</i>	0.532	0.78
Secondary	1.010	10.54***			
Tertiary	1.537	11.49***			
<i>Self-rated health status</i>					
Very good	–0.123	–0.88			
Good	–0.039	–0.63			
Moderate [†]	—	—			
Poor	–0.125	–1.34			
Very poor	–0.444	–1.65*			

IADLs = Instrumental activities of daily living.

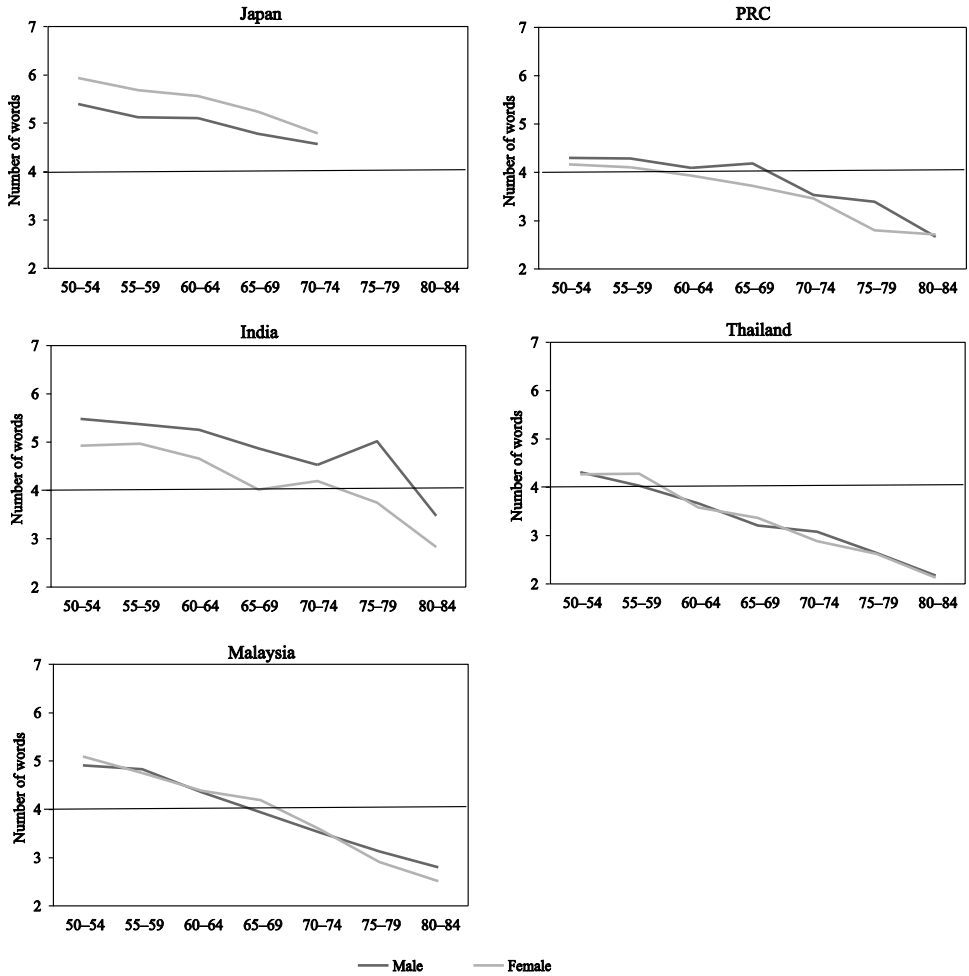
Notes: [†] denotes the reference group. Adjusted *R*-squared = 0.219. Number of observations = 3,680. ***, **, and * indicate 1%, 5%, and 10% levels of statistical significance, respectively.

Source: Authors' estimates based on data from the Malaysia Ageing and Retirement Survey of the Social Wellbeing Research Centre of the University of Malaya, Kuala Lumpur.

scores than men in these Asian countries,³⁷ Figure 3 reveals considerable differences across the five Asian countries—in the PRC and India, for example, women have distinctively lower cognitive scores than men. To account for the gap between our

³⁷In the case of India, the estimated coefficient for sex is statistically insignificant, presumably due to the small sample size.

Figure 3. Immediate Recall Scores in Five Asian Countries by Sex and Age Group



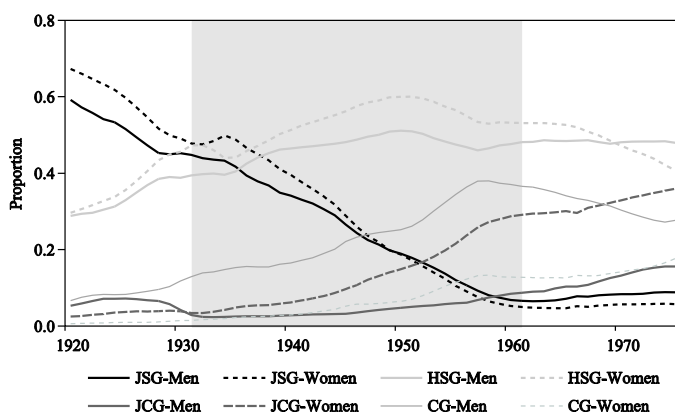
PRC = People's Republic of China.

Sources: Authors' calculations based on data from the following: (i) Japanese Study of Aging and Retirement of the Research Institute of Economy, Trade and Industry, Hitotsubashi University, Japan, and The University of Tokyo, Japan; (ii) China Health and Retirement Longitudinal Study of the National School of Development of Peking University, Beijing; (iii) the pilot portion of the Longitudinal Ageing Study in India of the Harvard T.H. Chan School of Public Health, Boston, the International Institute for Population Sciences, Mumbai, and the University of Southern California, Los Angeles; (iv) Malaysia Ageing and Retirement Survey of the Social Wellbeing Research Centre of the University of Malaya, Kuala Lumpur; and (v) Health, Aging, and Retirement in Thailand of the Center for Aging Society Research/Research Center of the National Institute of Development Administration, Bangkok.

regression results and the patterns in Figure 3, we need to pay attention to gender differences in educational attainment in these Asian countries. Once we control for education as we did in our regressions, women have an advantage over men in cognition, suggesting that Asia's gender difference in cognition performance is primarily caused by gender gaps in education.

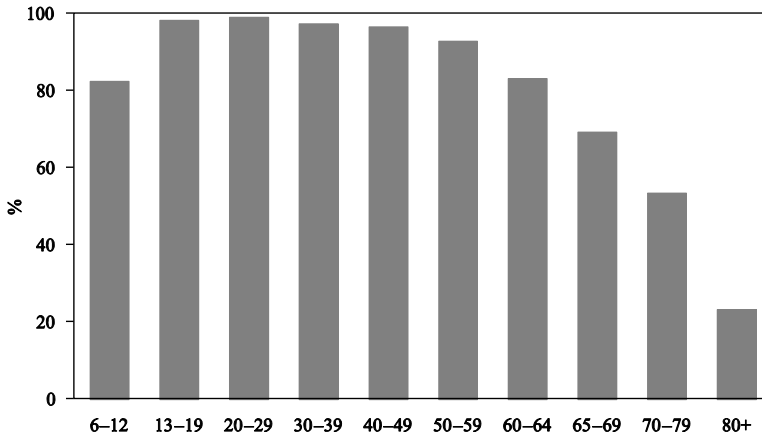
Although it falls outside the scope of this study, we are planning to carry out a series of simulation exercises in a future study by using the regression results for the five Asian countries generated here. In the case of Japan, for instance, the statistical results indicate that the cognitive ability of Japanese elderly persons is likely to improve due to the following potential factors: (i) the level of education among those 50 years and over is expected to rise at a phenomenal rate, as shown in Figure 4; (ii) future generations of the elderly are likely to have an advantage over past generations because children's nutrition started to improve considerably in Japan in the late 1950s when the school lunch program was introduced nationwide; and (iii) the use of modern communication technologies among the elderly is likely to increase at a remarkable rate because the overwhelming majority of young cohorts have already been exposed to extensive use of computers and mobile phones, as illustrated in Figure 5. By conducting various simulation exercises of this nature, we will be able to project to what extent cognitive functioning among older adults in Japan will improve, and how high Japan's CADR will be in the years ahead.

Figure 4. Changes in Educational Composition in Japan by Sex, 1920–1980



CG = University or higher, HSG = senior high school, JCG = junior college, and JSG = junior high school.
Source: Statistics Bureau of Japan. 2013. *Population Census 2010*. Tokyo: Japan Statistical Association.

Figure 5. Age-Specific Pattern of Using the Internet in Japan, 2016



Source: Ministry of Internal Affairs and Communications. 2017. *Communications Usage Trend Survey*. https://www.soumu.go.jp/johotsusintokei/tsusin_riyou/data/eng_tsusin_riyou02_2017.pdf.

VIII. Concluding Remarks

In recent years, the five Asian countries intensively analyzed in this paper have been facing increasingly difficult policy challenges induced by rapid population aging. Among these five countries, Japan's level of population aging has been the most pronounced over the past few decades. Japan has the highest proportion of those aged 65 and over, an indicator which has been used by demographers for more than a century. One of the main objectives of this study was to introduce from an innovative angle a new index to measure the level of population aging to shed a different light on policy-oriented research on this phenomenon. To compute this new index—the cognition-adjusted dependency ratio—we applied the mean age-group-specific immediate recall scores for Japan and four other Asian countries and compared the computed results with those derived from the US and various developed nations in Europe.

Our computed results have shown that Japan's pattern and level of age-related decline in cognitive functioning are highly comparable to those of many other developed nations, particularly those in the group designated as Continental Europe in previous research. This finding seems to have a few important policy implications for the aging Japanese economy, particularly its labor market. The population census data show that the size of Japan's total labor force, after reaching a peak in 1995, has been shrinking continuously, while the overall labor force participation rate has been on a

downward trend since 1970. Despite these substantial changes, Japan's age-based employment practices, which comprise lifetime employment, seniority wage system, and mandatory retirement age, remained virtually intact (Kato 2016). Particularly, Japan's policies related to the mandatory retirement age—requiring workers to leave the company at a relatively young age, typically at an age of 60—are considered extreme compared to the practices in other industrialized nations.³⁸ Due to the existence of such age-based employment practices, many Japanese businesses that face fierce competition from overseas rivals have been confronted in recent years with a shortage of highly qualified workers with specialized skills acquired from career experiences. Our research finding is not yet widely known in Japan's labor market, but once the market recognizes that older Japanese have reasonably good cognitive performance, the finding could provide a strong incentive for many employers to modify or even abandon the long-running age-based employment practices. This would allow a sizable number of older Japanese with a reasonably good level of cognitive functioning to be recruited, which would likely generate a considerable amount of economic dynamism.

It is also worth noting that among the selected Asian countries, Malaysia shows a pattern of change in age-specific cognitive functioning that is similar to the Southern European group, although Malaysia has somewhat lower scores than Southern Europe in all age groups.

More importantly, these inter-country comparative results based on cognition-adjusted dependency ratios are astonishingly different from the results emerging from the conventional old-age dependency ratios. This conclusion seems to justify the UN's recent efforts to raise awareness regarding the urgent need for remeasuring population aging with a view to formulating more efficient and effective policies to cope with rapid population aging in both developed and developing nations.

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³⁸In Western industrialized nations, cognitive performance is becoming increasingly important for labor market outcomes (Gordo and Skirbekk 2013).

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