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Population Aging, Economic Growth, and Old-Age Income Support in Asia

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Abstract

Developing Asia is facing the challenge of the aging population, as well as falling fertility. These twin phenomena now threaten the economic progress that the region has enjoyed the last few decades. However, its rising proportion of the elderly may come with the benefit of having a high saving rate that can be channeled to investments. This paper discusses the ongoing demographic transition, population aging, demographic dividend, and how it will affect the economic prospects of developing Asia going forward. A sound approach to sustaining economic growth and providing economic security for the elderly would strike the right balance between assets and public transfers while promoting high rates of human capital investment through investing in physical capital and human capital coupled with technological innovation.

Keywords: Aging, Demographic Transition, Economic Growth, Productivity, Asia
JEL Codes: J11, J14, J24

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1. Introduction

Developing Asia is facing the challenge of increasing older generation (65 years of age and beyond) and fewer numbers of children. While not all countries are under immediate threat, countries such as Japan and the People's Republic of China are already feeling the pressure. From an economic perspective, it means policies to balance the needs of the economy while taking care of the demands of aging population must be implemented. While developing Asia is set to continue its steady growth in the near term, it is undergoing major structural shifts (such as rebalancing between exports and domestic consumption, and rising inequality), which impinge on its medium- and long-run growth prospects. Demographic dividend is one of the major shifts, and its contribution as drivers of regional growth for some of Asia's largest economies is now coming to an end.

This paper will discuss the three distinct but related concepts and how it will affect the economic prospects of developing Asia going forward: demographic transition, population aging, and the demographic dividend. The demographic transition refers to the change from a high mortality–high fertility configuration to a low mortality–low fertility pattern. Improvements in public health cause mortality rates decline, which trigger population growth rates to rise. In time, fertility rates gradually decline, thus slowing population growth rates. Then, the modal age of the population increases with the age of the large elderly cohorts, or population aging. Meanwhile, the demographic dividend refers to the acceleration in economic growth due to an increasing population share of working-age individuals. Other things equal, an economy's output is larger with larger workforce, and when population aging sets in, the dividend becomes a tax on economic growth. A major factor in Asia's economic success is the demographic dividend. The immediate catalyst for the region's demographic dividend was a decline in fertility rates, which started as early as 1950s. This decline caused a corresponding decline in the youth-dependency ratio. As the relative size of the working-age population increased, not only was there a direct effect on economic growth, but there was also a positive, indirect effect that encouraged higher saving. If so, Asia's demographic dividend also contributed to the region's high saving and investment rates. Unfortunately for Asia, this favorable demographic structure is now giving way to older population profiles in which economically inactive retirees account for a high and growing share of the total population.

Like many other parts of the world, Asia's aging population reflects the confluence of two factors—falling fertility and rising life expectancy. To some extent, the prospective decline in the labor force can be mitigated by policies such as opening up to immigration, encouraging higher female participation in the workforce, and raising the retirement age. However, population aging has an adverse impact on labor supply and, in turn, on output. A main consequence of aging is that each worker has to support more and more retirees under public pension and health care systems. Thus, while demographic trends were conducive for economic growth in the past, these will be markedly less so in the future**.**

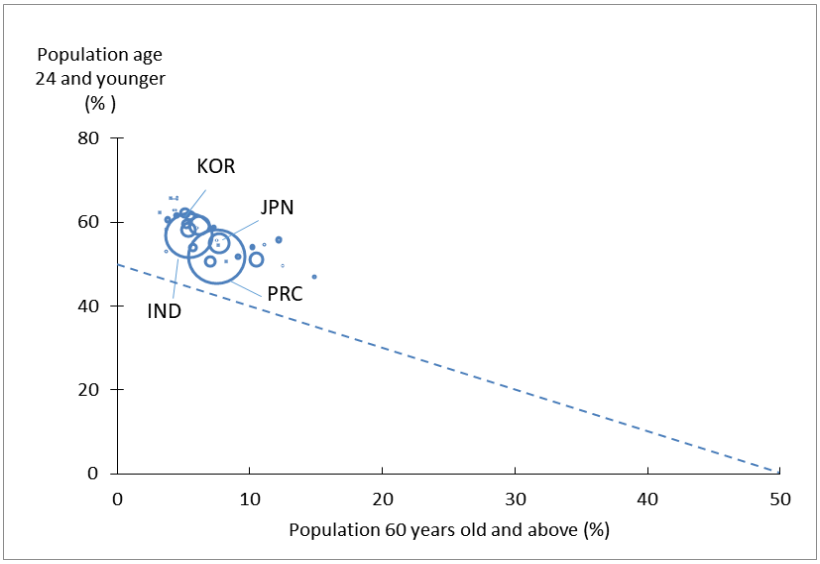
2. The demographic transition in Asia: key trends and stylized facts

Countries throughout Asia and the rest of the world are experiencing significant changes in the age structure of their populations. The economic challenges from these changes depend on the key features of the transitions themselves and the factors driving the demographic changes. These challenges vary by country.

2.1 Three phases of the demographic transition

Important changes in Asia's age structure began to take place as early as 1950. At that time, the age distributions of most Asian countries were heavily concentrated among Asians under age 25 years and the proportions of the age 60 and older group ranged from a mere 3% to 15%. Figure 1 provides a graphic summary of this relatively homogeneous demographic age structure.

Figure 1: Population age structure for Asia, 1950



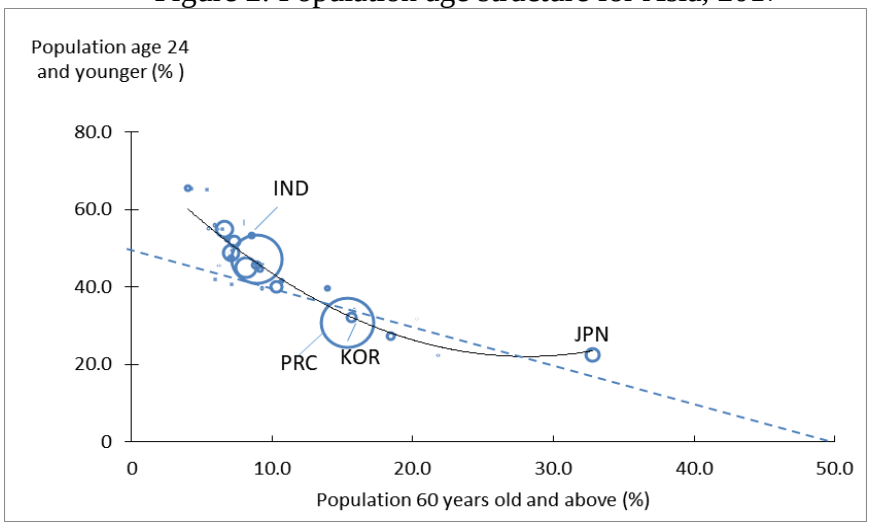
Note: PRC = People's Rep. of China; IND = India; JPN = Japan; KOR = Republic of Korea.
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2008 Revision.

The horizontal axis measures the proportions of persons aged 60 or over, while the vertical axis measures the corresponding proportion of persons age 24 and younger. The chart reads a point such as (3, 60) means that 3% of the population are elderly, and 60% are young, it can then be inferred that 37% [=100–63] of the population are of prime working age. The diagonal gridline is locus of points for which the population shares of the elderly and the youth sum to exactly 50%. The area of circle represents the size of total population.

A point above that line thus means that fewer than 50% of the population belongs to the prime working-age category, and a point below it implies that a country has a relatively low dependency burden (the combined population shares of the youth and elderly). In stark

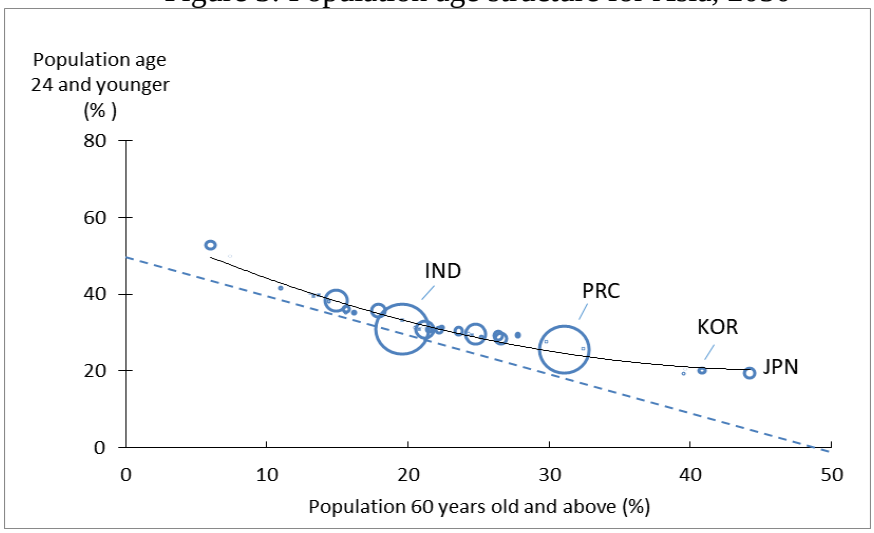
contrast, the population age profiles of Asian countries were more heterogeneous in 2017 (Figure 2), showing several country points moved down and to the right, with some crossing the diagonal line. Japan has become an outlier: its population having aged most rapidly.

Figure 2: Population age structure for Asia, 2017



Note: PRC = People's Rep. of China; IND = India; JPN = Japan; KOR = Republic of Korea.
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2008 Revision (accessed 10 April 2018).

Figure 3: Population age structure for Asia, 2050



Note: PRC = People's Rep. of China; IND = India; JPN = Japan; KOR = Republic of Korea.
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2008 Revision.

Figure 3 indicates the general movement of the country distribution of population age structures between 2017 and 2050 which will be a stretching out to the right so that the curve of best fit (black line) will become shallower and barely crossing the diagonal line. This shows that the populations of Asian countries will age quickly, in large part because

rapid declines in fertility have the effect of diminishing the sizes of the age 24 and younger population relative to the total population quickly as well. As a consequence, the dependency burdens will not ease as much between 2017 and 2050 as during between 1950 and 2017.

2.2 Why is Asia's age structure changing?

Changes in age structure are a consequence of the demographic transition. In pre-1950 Asia, birth and death rates were quite high, and populations grew relatively slowly or not at all. In the 1950s and 1960s, however, death rates started to decline. Lower mortality, particularly among infants and children, led to steep increases in the numbers of young people. Then birth rates declined as well. Subsequently, as the large birth cohorts of the 1950s and 1960s entered their prime working ages in the 1970s, the population share of the workforce swelled.

Over time, the decline in death rates reached the older ages as health care improved, resulting in persistent increases in life expectancy. People are more likely to survive their childhood years and could also expect to live well beyond the retirement age. The rates at which the population shares of the elderly in Asian countries are increasing have more to do with the precipitous declines in fertility in Asia than with increases in life expectancy (Tables 1 and 2). The population shares of the elderly in Japan, the Republic of Korea, and Singapore, for instance, are projected to reach such high levels, primarily because the very low fertility rates of these countries will lead to reduced population shares of working-age adults.

Table 1: Life expectancy at birth (years)

	1950	1975	2000	2017	2025	2050	2075	2095
Central and West Asia								
Afghanistan	28.6	40.4	56.9	64.2	67.2	71.6	75.0	77.7
Armenia	62.8	70.6	72.4	74.8	76.5	80.4	84.1	86.5
Azerbaijan	58.4	63.9	67.4	72.1	73.3	76.4	79.7	82.6
Georgia	60.6	69.6	72.6	73.6	75.2	79.0	82.8	85.3
Kazakhstan	55.1	64.3	64.6	70.0	71.8	76.1	80.1	83.1
Kyrgyz Republic	52.8	62.4	66.9	71.0	72.6	76.4	80.2	83.2
Pakistan	37.0	56.1	63.3	66.7	68.2	71.5	74.6	77.5
Tajikistan	53.0	62.1	66.5	71.3	73.0	76.9	80.7	83.6
Turkmenistan	51.3	60.2	64.2	68.0	69.2	72.1	75.2	77.9
Uzbekistan	56.1	64.0	67.7	71.4	72.7	75.8	79.1	82.0
East Asia								
China, People's Rep. of	43.8	65.5	73.1	76.5	78.1	81.8	85.2	87.4
Hong Kong, China	63.2	73.8	81.4	84.2	85.6	89.2	92.3	94.4
Mongolia	43.2	56.8	64.1	69.5	71.3	75.6	79.6	82.8
Republic of Korea	47.9	65.0	77.2	82.4	84.2	87.8	91.0	93.5
South Asia								
Bangladesh	40.7	52.2	66.7	72.9	75.7	80.9	85.1	87.5
Bhutan	32.3	43.7	62.9	70.7	73.6	78.1	81.9	84.7
India	36.6	52.5	63.5	68.9	71.0	75.0	78.5	81.5
Maldives	34.5	50.7	72.1	77.8	80.3	84.8	87.8	90.0

Nepal	34.0	44.9	64.1	70.8	73.5	78.4	82.3	85.0
Sri Lanka	54.5	67.0	73.2	75.6	77.5	81.8	85.4	87.7
Southeast Asia								
Brunei Darussalam	58.3	69.5	75.7	77.5	79.0	82.7	86.0	88.2
Cambodia	40.3	14.5	60.8	69.5	72.4	77.5	81.6	84.4
Indonesia	43.5	58.5	66.7	69.4	70.9	74.2	77.3	80.1
Lao PDR	40.9	48.4	60.3	67.2	70.1	75.0	78.9	81.8
Malaysia	54.8	67.2	73.2	75.5	77.1	80.9	84.5	86.9
Myanmar	36.1	54.0	62.9	66.8	68.2	71.1	73.9	76.4
Philippines	55.4	61.7	67.5	69.3	70.7	73.9	77.3	80.2
Singapore	60.2	71.0	79.2	83.3	84.8	88.1	91.2	93.6
Thailand	50.8	63.3	71.2	75.6	77.5	82.1	85.5	87.8
Viet Nam	53.5	66.1	73.8	76.6	78.5	82.8	85.9	88.2
The Pacific								
Fiji	52.2	62.2	68.0	70.5	71.9	75.3	78.9	81.8
Micronesia, Fed. States of	54.6	64.8	67.6	69.4	70.5	72.8	75.4	77.7
Papua New Guinea	38.3	53.7	62.6	65.8	67.2	70.2	72.8	75.2
Samoa	45.9	58.5	70.1	75.3	77.6	82.4	86.0	88.4
Solomon Islands	45.4	58.0	64.7	71.1	73.6	78.1	81.9	84.6
Timor-Leste	30.0	31.2	61.5	69.4	71.8	76.1	79.7	82.6
Tonga	58.6	66.9	71.2	73.3	74.7	78.3	81.8	84.6
Vanuatu	41.9	56.8	68.4	72.4	74.3	78.5	82.4	85.2

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2017 Revision, http://esa.un.org/unpd (accessed 17 April 2018).

Table 2: Fertility rate (children per woman)

	1950	1975	2000	2017	2025	2050	2075	2095
Central and West Asia								
Afghanistan	7.5	7.5	7.2	4.4	3.2	2.1	1.8	1.7
Armenia	4.5	2.6	1.7	1.6	1.6	1.7	1.7	1.8
Azerbaijan	5.2	3.8	1.9	2.0	1.9	1.8	1.8	1.8
Georgia	2.8	2.4	1.6	2.0	1.9	1.9	1.9	1.8
Kazakhstan	4.4	3.2	2.0	2.6	2.4	2.0	1.9	1.9
Kyrgyz Rep.	4.4	4.6	2.5	2.9	2.6	2.2	1.9	1.9
Pakistan	6.6	6.6	4.2	3.4	2.9	2.2	1.9	1.8
Tajikistan	5.4	5.9	3.6	3.3	2.9	2.3	2.0	1.9
Turkmenistan	5.3	5.6	2.8	2.8	2.5	2.0	1.9	1.8
Uzbekistan	5.3	5.5	2.5	2.2	2.0	1.8	1.8	1.8
East Asia								
China, People's Rep. of	6.0	3.0	1.6	1.6	1.7	1.8	1.8	1.8
Hong Kong, China	4.4	2.2	1.0	1.3	1.5	1.7	1.8	1.8
Mongolia	5.6	6.7	2.1	2.7	2.4	2.1	2.0	1.9
Republic of Korea	5.7	2.9	1.2	1.3	1.5	1.7	1.7	1.8

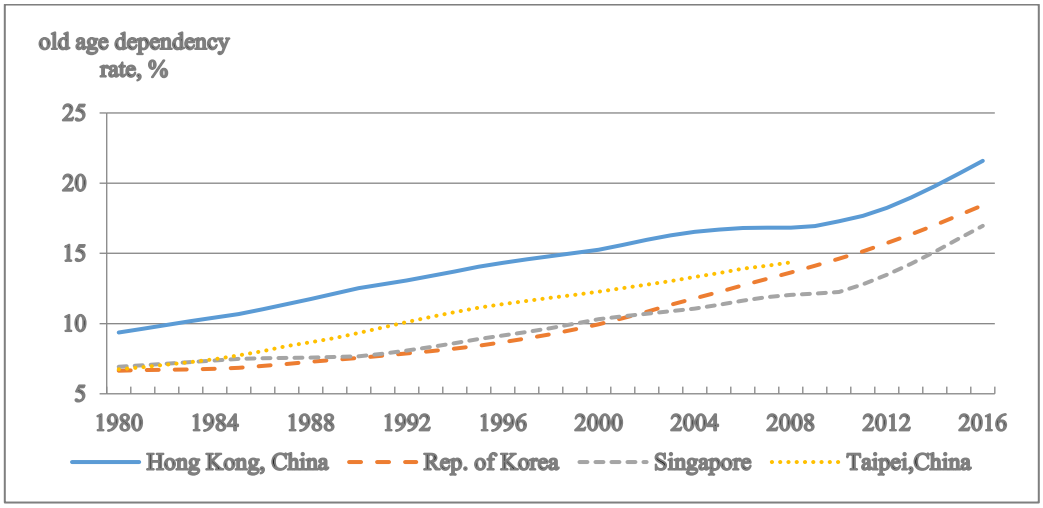
South Asia								
Bangladesh	6.4	6.6	2.9	2.1	1.8	1.7	1.7	1.8
Bhutan	6.7	6.7	3.1	2.0	1.8	1.6	1.7	1.8
India	5.9	5.0	3.1	2.3	2.1	1.8	1.8	1.8
Maldives	6.0	6.9	2.6	2.0	1.8	1.7	1.8	1.8
Nepal	6.0	5.8	3.6	2.1	1.8	1.7	1.7	1.8
Sri Lanka	5.8	3.6	2.3	2.0	1.9	1.8	1.8	1.8
Southeast Asia								
Brunei Darussalam	6.9	4.5	2.0	1.8	1.8	1.7	1.8	1.8
Cambodia	6.9	5.4	3.4	2.5	2.3	1.9	1.8	1.8
Indonesia	5.5	4.7	2.5	2.3	2.1	1.9	1.8	1.8
Lao PDR	5.9	6.2	3.9	2.6	2.2	1.8	1.7	1.8
Malaysia	6.3	4.2	2.5	2.0	1.9	1.7	1.8	1.8
Myanmar	6.0	5.2	2.9	2.2	2.0	1.8	1.8	1.8
Philippines	7.4	5.5	3.7	2.9	2.6	2.1	1.9	1.8
Singapore	6.6	1.8	1.3	1.3	1.3	1.4	1.4	1.4
Thailand	6.1	3.9	1.6	1.5	1.4	1.6	1.7	1.8
Viet Nam	5.4	5.5	1.9	1.9	1.9	1.9	1.9	1.9
The Pacific								
Fiji	6.6	4.0	3.0	2.5	2.3	1.9	1.8	1.8
Micronesia, Fed. States of	7.2	6.4	4.1	3.1	2.7	2.1	1.9	1.8
Papua New Guinea	6.2	5.9	4.4	3.6	3.2	2.5	2.2	2.0
Samoa	7.6	6.5	4.4	3.9	3.5	2.8	2.3	2.0
Solomon Islands	6.4	7.0	4.6	3.8	3.3	2.6	2.1	1.9
Timor-Leste	6.4	4.3	7.0	5.3	4.3	2.8	2.2	2.0
Tonga	7.3	5.5	4.2	3.6	3.2	2.6	2.2	2.0
Vanuatu	7.6	5.8	4.1	3.2	2.9	2.4	2.0	1.9

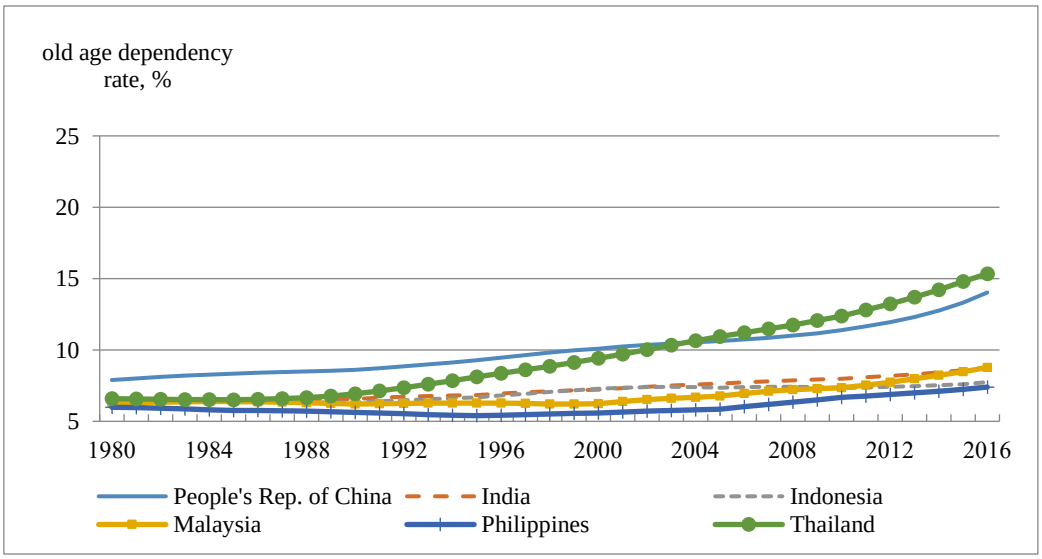
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2017 Revision, http://esa.un.org/unpd (accessed 17 April 2018).

3. Demographic diversity in Asia

Although the broad outlines of the changing population age structure described earlier appear to be common to all Asian countries. How they will play out in individual countries is uncertain and likely to show large variations. Countries can generally be classified based on the stage of demographic transition: (i) advanced stages (Japan, Republic of Korea, and Singapore), (ii) middle stages (the PRC and Thailand), and (iii) early stages (India and the Philippines) as shown in Figure 4.

Figure 4: Old-age dependency ratios for ten Asian developing economies, 1980-2016





Source: World Bank, World Development Indicators online database (accessed 10 April 2018).

For countries in the advanced stages, life expectancy rates have reached high levels and will continue to rise steadily. In contrast, fertility rates have declined to very low levels in Japan; Republic of Korea; Singapore; and Taipei, China—lower than those of the United States (US) and any European countries, and have not increased, unlike in the lowest fertility countries in Europe (Goldstein, Sobotka, and Jasilioniene,2009). These factors contribute to the steep rise of old-age dependency ratios of these countries and approach the levels of the industrial countries by 2090 (Figure 5a). The Republic of Korea will have three elderly persons for every five workers; the PRC, two for every five (Figure 5b). The challenge facing these countries is how to deal with a worsening old-age dependency burden, as the proportion of the working-age population shrinks and that of the elderly expands.

Figure 5a: Old-age dependency ratios, World regions, 1950- 2090

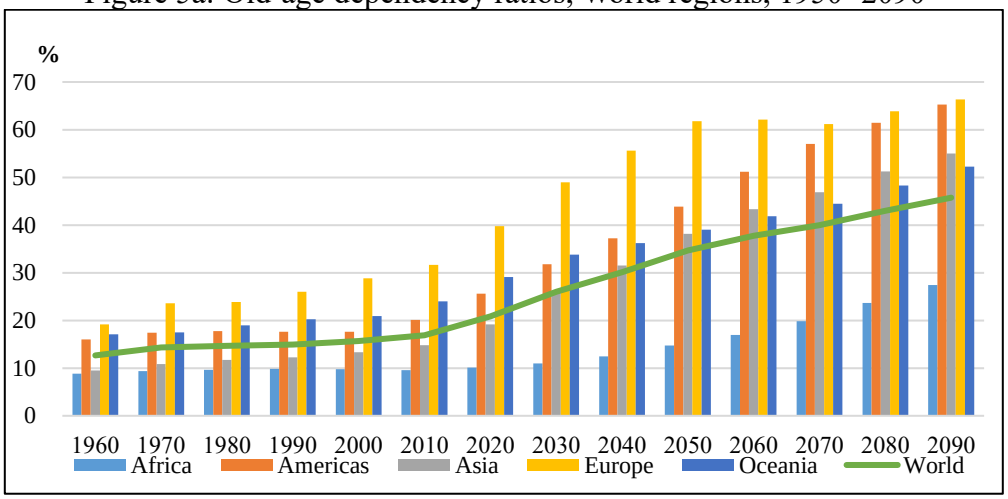
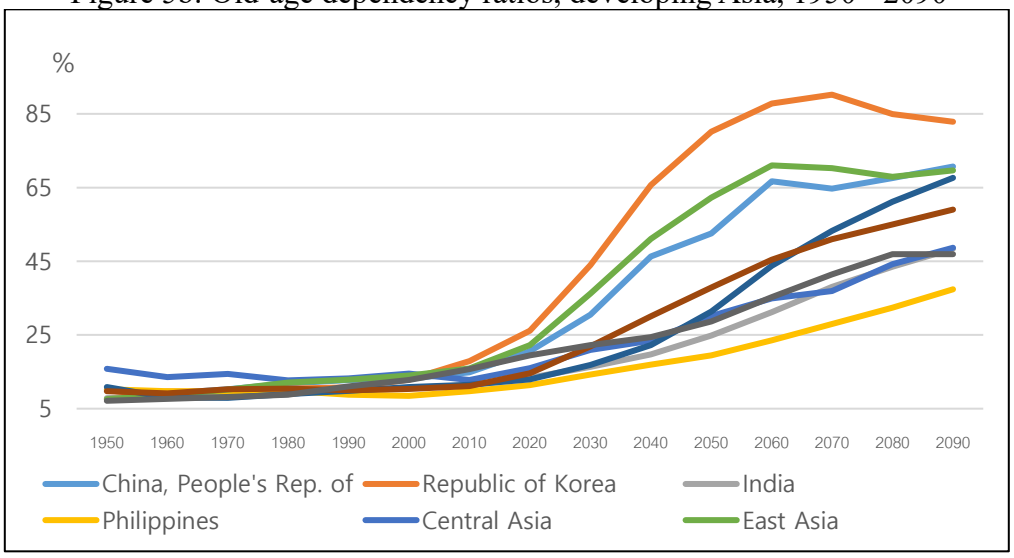


Figure 5b: Old-age dependency ratios, developing Asia, 1950 - 2090



Note: Old-age dependency ratio (each value is the average rate of 10 years); simple average was computed for subregions.
Source: http://www.ntaccounts.org (accessed 7 February 2018).

For countries in the middle or early stages, the speed of aging is projected to be neither as strong nor as fast. There is considerable uncertainty about their rates and degrees of fertility declines. Indeed, if these countries follow the path of East Asia and their fertility rates fall steeply to very low levels, their populations will age faster than indicated by the projections given here. Clearly, countries in the early stages of the demographic transition stand to benefit from population aging. The youth-dependency ratios of India and the Philippines, for instance, are projected to fall from 1:2 to 1:3 by 2050. In contrast, the corresponding ratios of middle- or late-stage countries are not likely to see any substantial changes.

3.1 The link between income level and population aging: an empirical analysis

A look at the demographic diversity of Asia indicates that richer Asian countries tend to be older than poorer Asian countries. Broadly speaking, high-income countries such as Korea and Singapore have the oldest populations, followed by upper middle-income countries such as China and Thailand, and then lower middle-income countries such as India and the Philippines, which have the youngest populations. Of course, there are exceptions such as Vietnam, which is lower middle-income but aging quite rapidly. Nevertheless, the broader pattern among Asian countries points to a clear association between population aging and income.

Therefore, it will be interesting and meaningful to take a more formal and rigorous look at the relationship between per capita income and population aging, proxied by the share of population aged 65 or older. More specifically, we perform simple panel data analysis using data from World Development Indicators for 179 countries in the period 1970-2018. Using a global sample gives us as much larger sample and hence more confidence in our empirical results. At the same time, there may be significant economic, social, cultural and other relevant differences across the regions of the world. These regional differences may have as significant influence on population aging. Therefore, we include regional dummies for Asia, Europe, Latin America and the Caribbean, Middle East, North America, Oceania, and Africa. Table 3 shows the descriptive statistics and Table 4 shows the results of the empirical analysis.

Table 3: Summary statistics of variables

Variable	Description	Mean	Std. Dev.	Min	Max
Population 65*	Population ages 65 and above (% of total population)	6.68	4.70	0.69	27.58
GDP per Capita*	GDP per capita (constant 2010 US$)	12,592.18	17,968.39	161.73	141,200.00

Note: Regional category refers to the guidelines of United Nation and the World Bank.
Source: www.worldbank.org, WDI (accessed 26 June, 2020).

Table 4: Random-Effects GLS Regression Result

Population Aged 65 and Above	Specification 1	Specification 2	Specification3
GDP per Capita	0.0001***	0.0001***	0.0001***
	(0.000)	(0.000)	(0.000)
Asia		3.905**	1.280***
		(1.568)	(0.485)
Middle East	-3.905**		-2.625*
	(1.568)		(1.492)
Africa	-1.280***	2.625*	
	(0.485)	(1.492)	
Europe	6.780***	10.685***	8.060***
	(0.825)	(1.552)	(0.691)
Latin America & the	0.868	4.772***	2.148***
	(0.621)	(1.509)	(0.433)
North America	2.559**	6.463***	3.838***
	(1.219)	(1.611)	(1.172)

Oceania	-0.494	3.410**	0.785
	(0.770)	(1.538)	(0.638)
constant	4.521***	0.617	3.241***
	(0.480)	(1.506)	(0.135)
Number of observation		6,673	
R^2		0.7094	

Notes: 1) Standard Errors adjusted for 158 clusters in country are in parentheses.
2) * p<.05; ** p<.01; *** p<.001.
3) Regional category refers to the guidelines of United Nation and the World Bank
4) Based on the results of heteroscedasticity, Random-effects GLS regression method has been implemented.
Source: Authors' calculation.

The three model specifications have different base regions—i.e. Asia for specification 1, Middle East for specification 2, and Africa for specification 3. The regression results show that GDP per capita is positive and statistically significant at 1% level. This suggests that the share of the population aged 65 and older tends to be higher in richer countries. The result confirms our conjecture about the link between income level and population aging based on stylized facts of aging in different income groups of Asian countries. The coefficients of the Europe and North America dummies are higher than those of the other regions. This implies that population aging is more advanced in the two regions than in other regions, including Asia. On the other hand, the coefficients of the dummies of the Middle East and Africa are negative and significant, which suggests that these two regions are younger than Asia.

More generally, the regression results show that population aging is more advanced than Africa in all other regions except Middle East. Perhaps due to cultural, religious and social factors, our evidence suggests that the Middle East may be younger than all other regions, including Africa. In particular, the Islamic culture of the Middle Eastern countries may contribute to their relative youth. As for Africa, its young population may be related to its economic and social underdevelopment. Our econometric analysis of a large global sample adds some empirical rigor to the conventional wisdom that rich countries tend to be older than poor countries. Our evidence has significant implications for Asia, which grew markedly faster than other regions in the last few decades. More specifically, our findings imply that as Asian countries continue to grow rapidly in the future, they are likely to face a significantly older population. Therefore, the time for Asian policymakers to start preparing for a greyer demographic landscape is now.

4. Economic support ratio

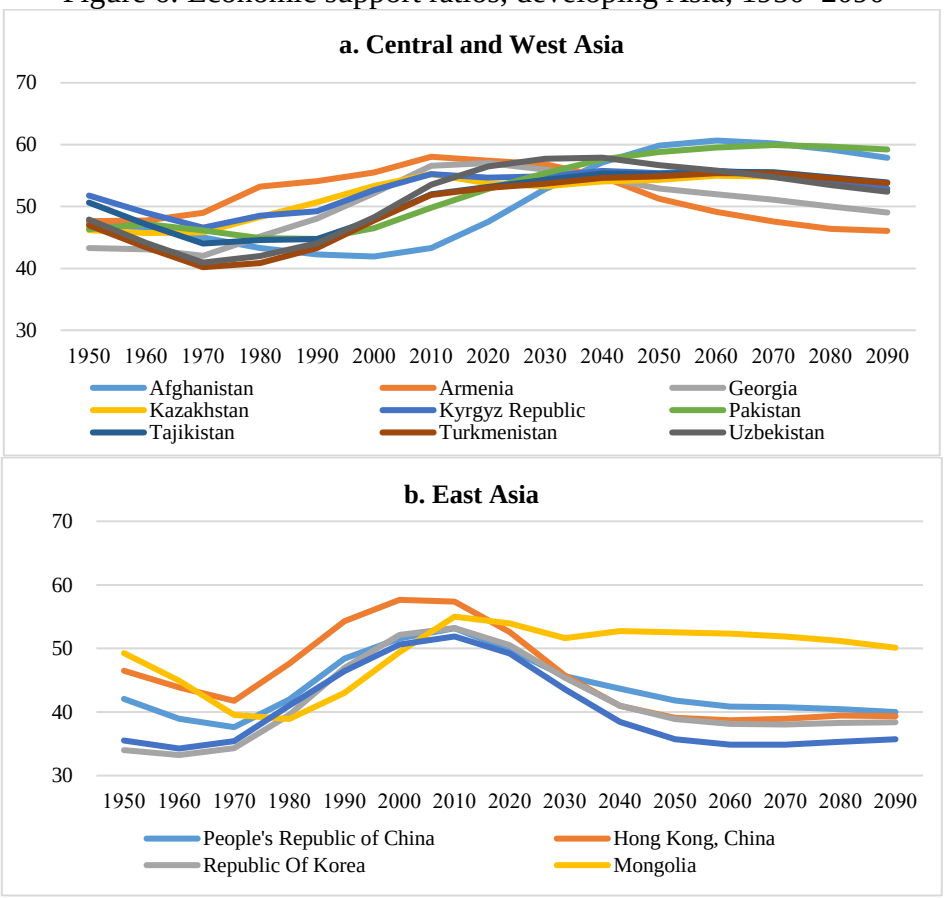
An implication of the demographic transition is that, as the median age of a country's population becomes older, its dependency burden shifts from having to support the young to having to sustain the old. The consumption needs of children and young persons are clearly very different from those of the elderly. What effects do these changes in the age composition have on the economy's capacity to meet its members' consumption needs?

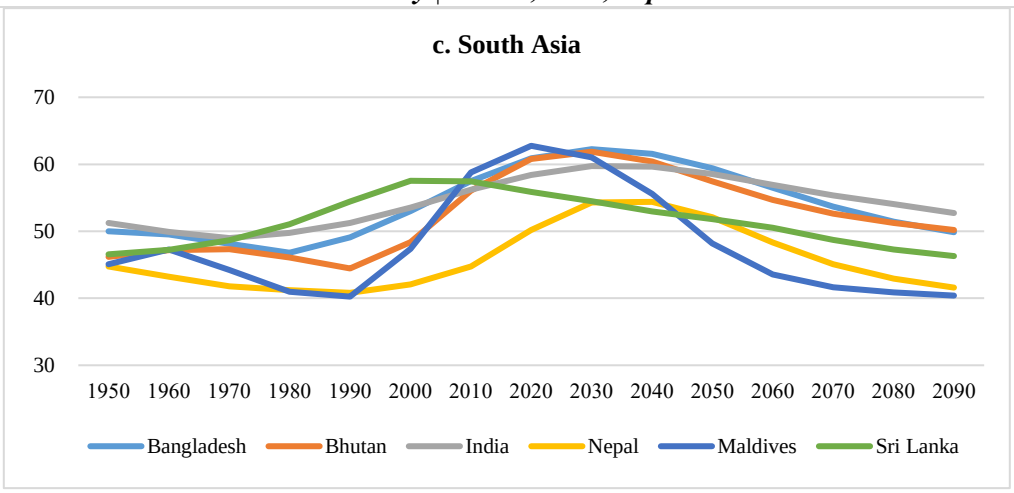
To gauge this, demographers use an indicator called economic support ratio, a measure of a country's labor income per currency unit of its consumption expenditures, assuming that its labor income and consumption profiles are those of a given base year and in view of its population age structure. The ratio captures some important characteristics of the labor force such as the value of labor of an additional worker in the economy by age,

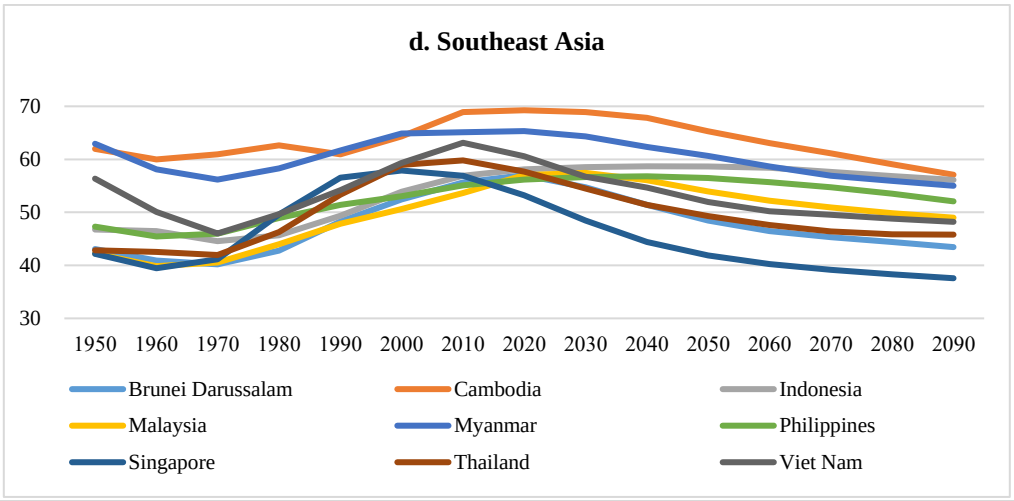
educational attainment, work experience, and the distribution of workers across industries and occupations. The ratio also circumscribes labor environment such as labor market and institutional parameters, labor force participation rates, unemployment rates, working hours, productivity, asset accumulation, and labor laws. Variation on consumption expenditures and patterns by educational attainment and with age are also incorporated.

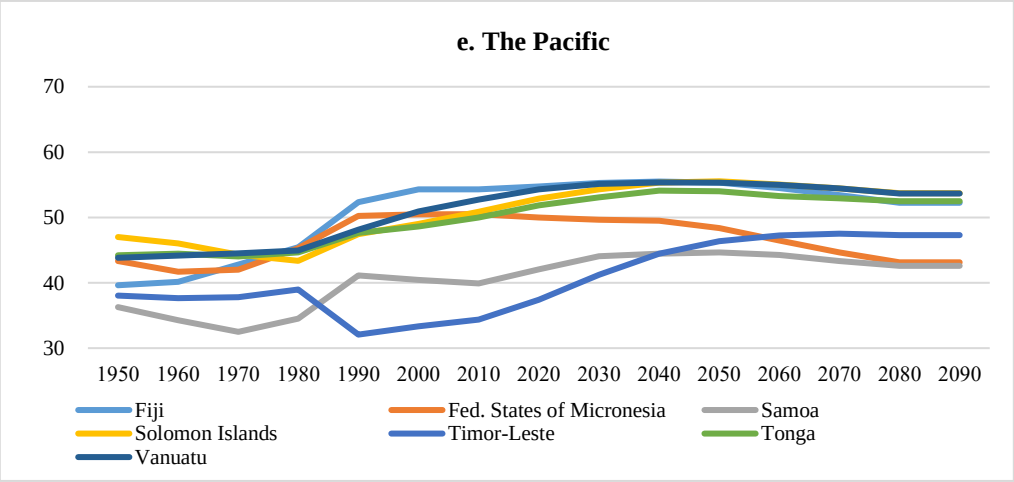
How a country's economic support ratio changes over time depends on the speed and size of changes in its population age structure. It also depends on behavioral, policy, and institutional differences that influence the timing of when workers enter and leave the labor force, the age patterns of unemployment and working hours, and how productive workers are. The age profile of consumption expenditures obviously affects the economic support ratio as well. The more expensive health and long-term care of the elderly, the steeper the rate of decline of the ratio as the population becomes older (). Figure 6 tracks the economic support ratios of Asian economies from 1950 to 2090. The estimates were constructed using UN population estimates and projections, based on the medium-fertility scenario, and the age profiles of labor incomes and consumption expenditures of the National Transfer Accounts (NTA) database.

Figure 6: Economic support ratios, developing Asia, 1950–2090









Note: Support ratios (effective number of producers per 100 effective consumers). Each value is the average rate of 10 years.
Source: http://www.ntaccounts.org (accessed 7 February 2018).

The NTA's low-income and consumption profiles were used to calculate the base-year weights for all economies, apart from Japan; Hong Kong, China; the Republic of Korea; Malaysia; Singapore; and Taipei, China, for which the high-income and consumption profiles were used. Figure 6b shows that the timelines of the economic support ratios of the East Asian economies are distinctive, because their age transitions have been so rapid and swings in their age structures are very large.

The PRC is an interesting case which can serve as a benchmark to compare other Asian countries. Between 1950 and the early 1970s, the PRC's ratio as child survival rates improved. Because of lower birth and youth-dependency rates, the index started its long ascent in 1972 and peaked in 2010. The PRC's ratio is projected to decline in the next few decades, as smaller cohorts will begin entering the workforce and the elderly population will live longer.

In the case of Asian developing economies, most started with initial declines in their economic support ratios, before these started to climb in the 1980s. Many countries in the region are currently benefiting from the ratios which will persist until next two decades, with the exception of East Asia subregion. From 2040, declining ratios will be pervasive as induced by the changing demographic structure in these countries.

5. Demographic Transition and Economic Growth in Asia

The consequences of demographic transition for Asia's growth are multi-faceted. There are four channels by which changes in the population age structure affect economic growth: the workforce and the dependent population, saving, physical capital accumulation, and total factor productivity (TFP).

5.1 Demographic changes and saving rates

The most familiar idea about the relationship between population and capital is embodied in the Solow growth model. Solow showed that given a constant saving rate, lower labor force growth would lead to an increase in capital per worker and per capita income (Solow, 1956). Studies including Tobin (1967), Cutler, Poterba, Sheiner and Summer (1990) and Mason and Lee (2007) have examined how changes in population age structure influence the capital–output ratio and labor productivity to understand how the aggregate saving rate is influenced by changes in population age structure based on the lifecycle saving model (Lee and Mason, 2010; Romero, Patxot, Renteria, and Souto, 2010 and Mason, Lee and Lee2010).

An important finding of these studies is that the link between population aging, saving, and capital will depend, to a significant degree, on the extent to which saving is motivated by lifecycle concerns. This, in turn, will depend on the extent to which the elderly will rely on continued work, adult children, and public transfer programs rather than on personal wealth to support their old age consumption.

Many studies on saving rates found that it rises and then falls over the course of the demographic transition. This is true for Asia where population age structure are often driven by saving rates in Asia, which have experienced especially large swings during the demographic transitions (Mason, 1981; Fry and Mason, 1982; Higgins and Williamson, 1997; Higgins, 1998; Bosworth and Chodorow- Reich, 2007).

Several explanations were provided to address why these patterns have been so important in Asia, including the rapid rate of economic growth, less reliance on public

transfer systems for old age support, and the speed of the demographic transition. Using historical and contemporary data, Kinugasa and Mason (2007) showed that fast increases in life expectancy led to high saving rates and increases in wealth per capita. This important feature of their results is confined to Asia, where transfer systems tend to be less important for old-age support than they are in Europe and Latin America.

The empirical evidence about saving and demography may not be fully captured as saving may also be very context dependent (Zhang, 2005) while behavioral responses to population aging are quite complex. Increases in life expectancy and the duration of retirement may influence the age at retirement (Bloom, Canning and Grham,2003), the extent to which the elderly can rely on family members for support, and the magnitude of public transfer systems (Preston, 1984).

Lee, Mason and Miller (2003), for example, concluded that changes in age structure can explain US saving trends but not the sharp increases in saving in Taipei,China, which can instead be explained by changes in population age structure combined with a rapid shift in the old age support system from familial transfers to lifecycle saving. A series of literatures indicated that the age structure of the population has a big influence on economic growth (Bloom, Canning and Fink, 2010; Park and Shin 2011). Some revealed that a higher proportion of the elderly reduces productivity and savings, and increases government expenditures (Fougère, Harvey, Mercenier, and Mérette, 2009; Bloom, Canning and Finlay ,2010; Sharpe 2011; Walder and Döring 2012). The demographic shift most likely intensifies the old-age dependency ratio, implying that a smaller working age group supports a larger elderly group (Navaneetham and Dharmalingam 2012; Lee, Kim and Park, 2017).

5.2 Demographic changes, workforce, and labor productivity

Demographic transition has profound implication on the course of economic and social development. Young population with expanding workforce is closely associated with accelerating growth – a phenomenon commonly known as "demographic dividend". It is estimated that as much as 33% of the growth in East Asia during 1965-1990 can be attributed to favorable demographics (Bloom, Canning, and Malaney, 2000). Today, many parts of Asia are entering the next stage of demographic transition as its working-age population begin to decline and age. Population structure and dynamics can turn from economic tailwind to headwind, lowering productivity, reducing consumer market size, and resulting in slower growth (Chomik. McDonald, and Piggott,2016, Flochel, YIkeda,Moroz, and Umapathi,, 2015, Bloom, Canning, and Finlay, 2010).

Maestas, Mullen, and Powell (2016) looked at US data to see if the same negative relationship between aging and state output per capita can be found using a panel data. The results showed that a 10% increase in the population aged 60 and above led to a 5.5% decline in per capita gross domestic product (GDP) growth rate. The authors decomposed the effect on GDP per capita into changes in labor force participation and productivity growth and found out that only a third of this decline is due to the smaller labor force while two-thirds of the decline is explained by slower labor productivity growth.

Several studies documented that a higher share of the older population in the workforce leads to lower productivity (Tang and MacLeod, 2006) and hence, lower growth (Gordon 2016, as cited in Acemoglu and Restrepo, 2018). Wasiluk (2014) projected a 0.25 percentage point decrease in annual productivity growth rate for Germany, due to labor-force aging. In a cross-country study covering 1960 to 1990, Feyrer (2007) looked across different

age groups to see the relationship between demographic changes and aggregate productivity. Using the 40~49-year-old age group as a base, he found that a 5% increase in this cohort over a ten-year period is associated with a 1-2% increase in productivity per year for that period. The age group 15 to 39 was associated with lower productivity. However, results are mostly mixed for the older age groups of 50-59 and 60 and up.

Intuitively, older workers may be more prone to skill obsolescence and that aging workforce has often been associated with lower productivity (IMF 2016). This seems the case in 10 Canadian provinces during 1981-2001, when Tang and MacLeod (2006) noted that older workers are, on average, less productive than younger workers and that labor force aging has a negative effect on productivity. Firms with older workers are not incentivized to update their technologies as often had they had younger workers (Wasiluk 2014; Meyer 2007) but evidence suggested that countries are mitigating the effects of a decreasing share of the working-age population by increasing human capital investments, and the gains from second demographic dividend resulting from higher savings stemming from adult longevity.

Alesin,Spolaore and Wacziarg (2005) presented another view that aggregate productivity tends to be higher in a country with older, more experienced workers. Since productivity grows fastest and peaks in ages 35–54, the productive capacity of a country with a large proportion of prime-age workers should be markedly higher than those with relatively more, younger or older workers. Using a balanced panel of 84 countries, Gomez and Hernandez de Cos (2008) found that an increase in the share of prime-age workers has a positive but curvilinear effect on per capita GDP.

A truck assembly plant study by Borsch-Supan and Weiss (2016) in Germany observed that even in an environment where physical skills are more relevant, individual-level average productivity increases up to the age of 60 due to the improved health. Burtless' (2013) study on the US found that there was little evidence that showed aging led to lower productivity, saying that the elderly workers today are not comparable to that of earlier generations because the elderly now are more educated.

To improve productivity of elderly workforce, making appropriate adjustments in the workplace such as lighting improvements or providing ergonomically-designed desks can help. A common finding from Meyer (2007), and Zwick and Göbel (2013) cited that cultivating diversity in teams while toning hierarchy based on seniority may also contribute to boosting relative productivity and greater adoption of new productivity-boosting technologies.

5.3 Aging and changing demand

A number of studies by Weil (2006), Sobotka, Skirbekk, and Philipov (2010), and Börsch-Supan (2013) confirmed that population aging is a global phenomenon, although the extent and speed of aging varies enormously across countries. Due to the weakening of physical ability, tastes and demand, studies by Narciso (2010); Bloom, Canning and Fink(2010); Lisenkova, Mérette and Wright (2012); and Walder and Döring (2012) showed a negative correlation between population aging and economic growth. Changes in public expenditure, consumption and saving associated with population are viewed as sources of the significant negative effect on economic growth.

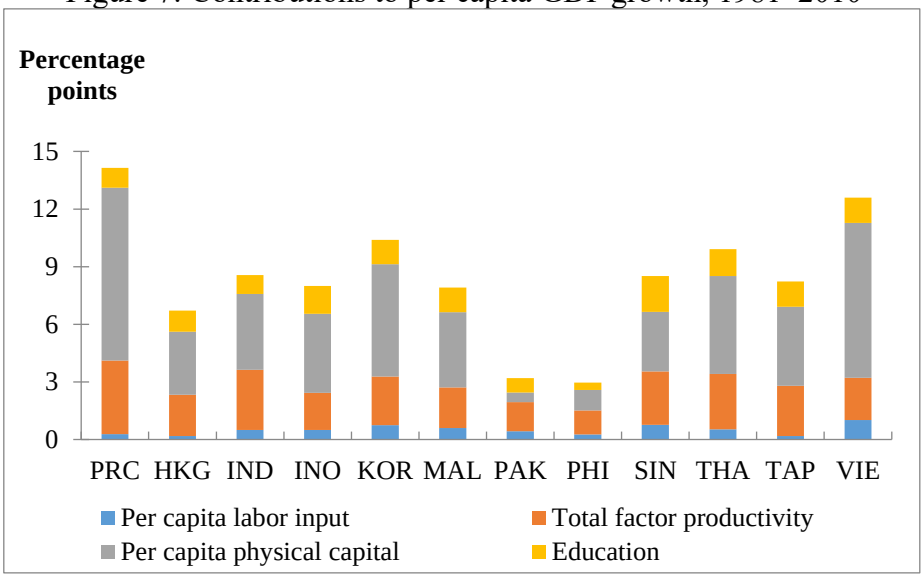
The adverse impact of population aging on economic growth has been significant, especially since the global financial crisis (Lee and Mason, 2011). Making use of median values for the share of pensioners in the population, Antolín, Dang and Oxley (2001)

estimated pension benefits, health care spending and other age-related spending of Organisation for Economic Co-operation and Development (OECD) member countries over 2000–2050. Their study predicts an increase in age-related spending of around 6 percentage points to GDP. Pension reforms can, to a certain extent, compensate for the adverse impact of older populations on sustainability of pension systems. Rising share of the old-age population may change the structure of demand toward goods and services for the elderly, which, in turn, may induce increases in the investment rate to bring about the required structural changes in production.

5.4 Total Factor Productivity

Total factor productivity (TFP), as first espoused by Tinbergen (1942) and widely developed by Domar (1962) and others, is the result after accounting for real output and factor inputs. Studies have mentioned that assuming the output share of labor to be 0.6 (the standard in the literature) will increase the growth rate of output per capita because it means the improvements in TFP. The improvement of TFP could be brought by the structural changes in the economy as a consequence of changes in the population age structure and thorough innovation. Figure 7 shows the relative contributions of the growth rates of labor, capital, education, and TFP to per capita GDP. The figure indicates that, in most countries, physical capital and TFP played major roles in economic growth. Consistent with past literature, high physical capital relates to high investment rates, thus increasing productive capacity. For the PRC, TFP contributed more than physical capital accumulation to growth.

Figure 7: Contributions to per capita GDP growth, 1981–2010



PRC = People's Rep. of China; HKG = Hong Kong, China; IND = India; INO = Indonesia; KOR = Rep. of Korea; MAL = Malaysia; PAK = Pakistan; PHI = Philippines; SIN = Singapore; THA = Thailand; TAP = Taipei,China; VIE = Viet Nam.
Source: Based on Park and Shin (2011), recalculated the TFP with PWT9.0.

Shortage of young and middle-aged labor, a consequence of aging, can in fact induce the adoption of robots and automation (Acemoglu and Restrepo, 2018). Their study estimated, using cross country data from 1993-2014, that a 10-percentage point increase in the share of aged workers (56 years old and above) prompts the adoption of robots by up to

0.25 installations per thousand workers on average. In Europe, higher government spending on research and development reduced the negative effect of aging on TFP growth (Aiyar, Ebeke, and Shao,2016). Technological changes and innovation tend to occur or get induced as responses to relative resource endowments hence increased adoption of technology among aged and aging countries is not coincident but likely endogenous in process (Vernon and Hayami, 1984).

6. Policy options for sustaining growth in the face of the transition

One strategy for responding to population aging is to encourage capital accumulation. Many of the fundamental insights were established by Modigliani and Brumberg (1954) and Tobin (1967) citing the economic lifecycle for saving and investment has repercussions because the old-age deficit is funded in part by asset-based reallocations. Population aging will lead to an increase in the demand for assets for three reasons. First, to the extent that longer life expectancy leads to longer retirements, the incentive to accumulate more during the working years will increase. Second, because fertility is lower, fewer resources may be devoted to childrearing and more to saving for retirement. The third reason is that presumably, older individuals are wealthier because they have accumulated wealth through their assets over time.

The strength of the relationship between age structure and capital depends, however, on the nature of the old-age income support system. The primary focus has been the possibility that public transfers will crowd out savings (Feldstein 1974, Gale 1998; and Munnell, 1974). This idea has been explored in many industrialized countries and to some extent in developing countries. These, and other similar studies help evaluate existing transfer systems, guide the development of new systems, and anticipate the implications of alternative reform proposals.

Social security reform, in particular, has been the subject of an enormous amount of research (Feldstein and Samwick, 2001; and Krueger and Kubler, 2002). Evidences suggested that East Asian countries have actively pursued the high savings, high investment paradigm. For example, Singapore institutionalized this approach to aging through its Central Provident Fund, a compulsory savings plan where citizens are required to save a high fraction of their earnings to cover for their retirement, housing and healthcare. The fund has led to high rates of savings, investment, and economic growth. This is quite different from the public pension systems in Japan, Europe, Latin America, and the US that provide for retirees out of current taxes and therefore have no positive growth effects.

The experience of other East Asian countries indicates that forced savings may not be required at very high savings rate with age transition in the absence of mandatory schemes. This is possible, despite East Asian economies' rapid population aging, since it has low reliance on public transfers. The incentive to save more generated by population aging is not undermined by large public transfers to the elderly (Feldstein, 1974; Gale 1998, Lee, Mason and Miller, 2003; and Lee and Mason, 2010).

Nevertheless, healthcare for the elderly is a large and increasing cost that is often heavily subsidized by the public sector, and familial transfers to the elderly is very prominent in Asia. This may lead to large implicit debts that are shared by taxpayers and the adult children of the elderly. If the needs of a growing elderly population are met through greater reliance on lifecycle savings, population aging will lead to an increase in assets with

favorable implications for economic growth, and can lead to the second demographic dividend (Mason and Lee, 2007). According to estimates by Lee and Mason (2011), population aging will lead to substantial capital deepening, a strategy very much in line with Asia's traditionally high saving and investment rates.

Table 5 shows that pension assets in ADB developing member countries would rise, compared to total labor income from 1.2 times in 2010, to 2.1 times in 2030, and 2.7 times in 2050. This capital deepening should provide a boost to economic growth that easily dominates the effects of a declining support ratio.

Table 5: Pension Assets Relative to Labor Income in Asia and the Pacific from 2010 to 2050

	Low income profiles			High income profiles		
	2010	2030	2050	2010	2030	2050
Asia-Pacific Countries	1.6	2.4	3.0	1.1	1.6	2.0
Developing Member Countries	1.2	2.1	2.7	0.8	1.4	1.8
Central and West Asia	0.9	1.3	1.9	0.6	0.9	1.3
East Asia	1.4	2.4	3.0	0.9	1.6	2.0
South Asia	0.9	1.3	2.0	0.6	0.9	1.3
Southeast Asia	1.1	1.9	2.5	0.8	1.3	1.6
Pacific Island Nations	0.7	1.0	1.4	0.5	0.7	1.0
Non-developing member countries	2.9	3.7	4.4	1.9	2.5	3.0

Source: Authors' calculation, based on NTA database (accessed 10 March 2018).

Another possible response to population aging is to scale up investment in human capital. Children rely almost exclusively on transfers to fund their lifecycle deficit (Park, Lee, and Mason, 2012), but countries vary in the extent to which those resources are provided through the public sector rather than the private sector. They also vary a great deal in the extent to which transfers are devoted to investments in human capital, i.e. education and healthcare. Asia's population aging is primarily a consequence of low fertility.

The total productivity of the working-age population is not, however, determined exclusively by the number of workers. Total labor income could be raised by increasing the quality of the labor force through investments in human capital (Becker and Barro 1988). An analysis by Lee and Mason (2010) showed that the impact of spending on education is strong enough to offset the adverse effects of population aging, but this conclusion depends on the effectiveness of the investment.

It should be emphasized that the two paths to successfully cope with population aging—investing in physical capital and human capital—are not mutually exclusive. A sound approach to sustaining economic growth and providing economic security for the elderly would strike the right balance between assets and public transfers while promoting high rates of human capital investment. Since population aging is enduring, it is important that countries should not delay implementation of necessary policies and practices, to ensure continued economic growth.

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