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An International Collaborative Study of Responses to Low Fertility and Population Aging(Ⅱ)

: Challenges and Policy Responses to Population Aging

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An International Collaborative Study of Responses to Low Fertility and Population Aging(II): Challenges and Policy Responses to Population Aging

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I Introduction: Sub-one Fertility–A Dark Cloud with Silver Linings

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Korea is now experiencing sub-one fertility, with a total fertility rate of only 0.98 birth per woman. Low fertility leads to population decline and population aging, and if sub-one fertility persists population decline will be very rapid and population aging quite severe. This is a matter of great concern, and many experts in Korea are working to understand why fertility is so low and what policies should be pursued that would support women who currently bear responsibility for reproduction and to a considerable degree childrearing.

Although the demographic situation in Korea is an important long-run problem, the purpose of this brief introduction is to point out ways in which population decline and aging are positive developments and to discuss some of the ways that responses to the demographic situation in Korea can be improved. Our purpose is to highlight the broad range of issues that are relevant, while acknowledging that evidence on some topics is

incomplete and some issues are controversial. Nonetheless, it is critical that discussions of low fertility, population decline, and population aging consider the broad range of relevant issues. With this goal in mind, we offer four favorable effects and four ways that the response to aging can be improved.

Four favorable effects

1. Reduced environmental stress

For many decades, rich and poor countries alike were experiencing rapid population growth that, in part, fueled growth in GDP and aggregate consumption. The era of population-driven economic growth is coming to an end, however, and in the future aggregateeconomic growth will be driven primarily by productivity growth, e.g., output per worker. In its latest projections, the UN expects global population to increase to 10 billion, growing at an annual rate of about 0.67 percent per year. Incorporating the effects of age structure and country differences in labor income, the effective work force is expected to growth by only 0.16 percent per year over the same period (Mason et al. 2019). Lower fertility and slower population growth in rich countries, Korea included, will relieve environmental stress.

2. Longer life

Although low fertility has been the primary driver of aging in high-income countries, increases in survival at older ages have also played an important role. This represents an extraordinary achievement – a gain in welfare that is not captured in standard economic statistics such as per capita income. Gains in life expectancy have been particularly spectacular in Korea, as shown in Table 1 (United Nations Population Division 2019).

〈Table 1-1〉 Life Expectancy at Birth, Both Sexes Combined

	1960	2019 (est)	Increase (years)
Korea	55.2	83.0	28.2
Japan	67.9	84.6	16.7
Taiwan	64.2	80.5	16.3
Germany	69.5	81.3	11.8
United States	69.9	78.9	9.0

Source: UN, World Population Prospects 2019

3. Increased capital deepening

An increase in capital per worker is referred to as capital deepening and is beneficial to economic growth because it leads to higher worker productivity (Solow 1956). Slower growth in the labor force leads to capital deepening because less investment is needed to provide capital for new workers and more investment can be used to provide capital for existing

workers. Samuelson hypothesized many years ago that lower fertility would lead to higher standards of living because of its capital-deepening effects, but eventually to lower standards of living because of the effects of old-age dependency (Samuelson 1975). A recent study by members of the NTA network concluded that moderately low fertility, a TFR of around 1.7 births per woman, would typically produce high standards of living. Below that level of fertility, the effects of old-age dependency would outweigh the effects of capital deepening (Lee, Mason and Members of the NTA Network 2014).

4. Enhanced human capital

Low fertility has facilitated sharp increases in human capital spending. Like capital deepening, human capital spending has helped to raise labor productivity and increase economic growth. Human capital spending has increased to particularly high level in East Asia, as can be seen in Table 2. Human capital spending in this table is a synthetic cohort measure calculated as the sum of age-specific spending over the 3 to 26 year age range. All values are normalized on per capita labor income of the 30-49 year age range. Korea's value of 630% means that providing the current average level of human capital to a child over his or her lifetime requires the equivalent of the pre-tax labor income of 6.3 adults in the 30-49 age range.

Korea ranks first among all high income countries for which estimates are available.

〈Table 1-2〉 Human capital spending in selected high income countries

Selected Countries	Human capital spending as percent of labor income at age 30-49
South Korea	630
Taiwan	610
Japan	530
Italy	520
United States	420

Source: National Transfer Accounts: Data Sheet 2016. East-West Center, Honolulu.

Four Ways to Improve Responses to Aging

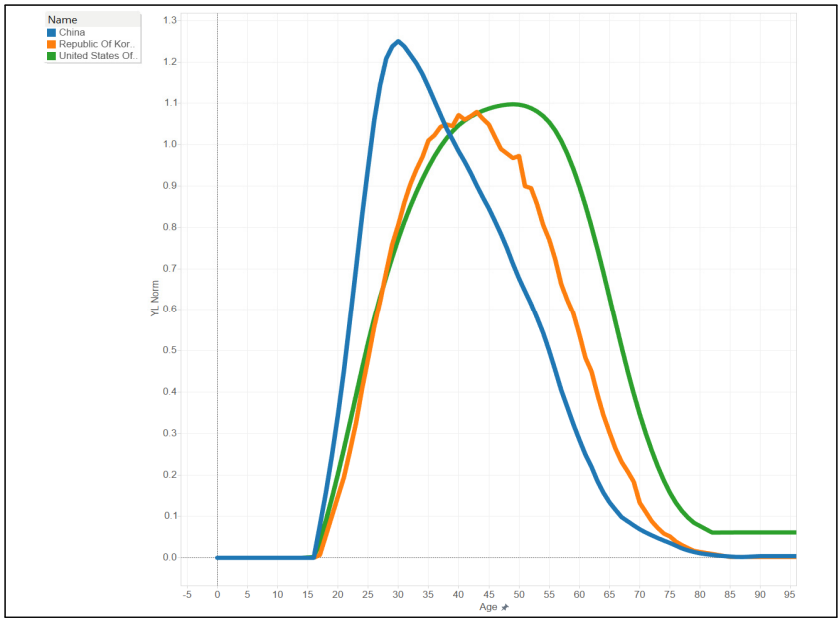
1. Increase contributions by workers

A major concern about low fertility is that it leads to slower growth in the population in the working-ages and the working-age population relative to the number of seniors. The working age population is a convenient construct, but there is no inherently fixed age span during which people work. Moreover, the amount that people contribute through their labor can vary greatly with age.

In fact, labor income can vary considerably over the lifecycle, as shown by the age profiles of labor income for China, Korea, and the United States in Figure 1. The labor income profiles are

normalized on the average of labor income for the 30-49 age range so that the figures reflect the age pattern of labor income but not differences in the levels of labor income between the three countries.

[Figure 1-1] Per capita labor income by age, China, Korea, and the US. Values are normalized on average per capita labor income over the 30-49 age range.



Source: www.ntaccounts.org.

Labor force participation is much higher at older ages than might be inferred from Figure 1. In fact, participation rates are higher in Korea than in the United States. However, labor income per worker drops very sharply with age in Korea. If labor

income at older ages were to rise in Korea, it could substantially offset the effects of aging on the effective labor force. Better health and better skills among the elderly could help to achieve this goal. Employment-friendly policies on the part of government and the private sector could also play a significant role (Lee 2019).

2. Control the costs of aging

High levels of consumption at old-ages, health care spending in particular, is one of the major sources of strain associated with population aging. Korea is distinctive in this regard as shown in Table 3. The values are the cumulative per capita consumption over the 20-year age range, 65-84, as compared with per capita consumption over the 30-49 age range. A value of 20 indicates that per capita consumption by seniors is the same as per capita consumption for prime age adults. Korea, with a value of 19.6, ranks lowest among the 21 high-income countries for which estimates are available. Japan and the United States are ranked lowest with consumption by seniors that is on average 50 percent higher than consumption by prime-age adults.

〈Table 1-3〉 Cumulative effective consumption for ages 65-84, values are normalized on per capita consumption of 30-49-year-olds

Country (rank)	Cumulative consumption
Korea (1)	19.6
Taiwan (2)	20.2
Japan (20)	29.4
Italy (10)	23.8
Germany (16)	26.1
United States (21)	30.1

Note: Rank is among 21 high-income countries.
Source: Mason et al 2019 Global Trends of Population and the Economy draft.

Aging would have a more severe effect if consumption were high along the lines of Japan and the United States. Consumption by the elderly might be viewed as too low in Korea, but efforts to raise standards of living among the elderly will be more difficult as Korea's population ages.

3. Improve public support for seniors

Korea relies less on public transfers to support seniors than many other high-income countries (Mason and Lee 2018). Net public transfers (transfer inflows less outflows) to those 65 and older are only 36 percent of their lifecycle deficit (difference between consumption and labor income). This is very similar to the importance of net public transfers to seniors in the United States, but the public sector plays a much more modest role in Korea than in most other high-income countries. Whereas many

high income aging countries are focused on retrenching their public sectors, Korea may have more space to increase public transfers to seniors.

〈Table 1-4〉 Net public transfers as a percentage of the life-cycle deficit, 65 and older

Korea	36
Japan	57
France	73
Germany	71
Italy	81
United States	37

Source: Andrew Mason and Ronald Lee, 2018 "Intergenerational Transfers and the Older Population," Future Directions for the Demography of Aging, National Academy of Sciences, Washington, DC.

4. Improve gender-work-life balance

Fertility has dropped to very low levels in Korea, but child-rearing is a heavy burden for women who do have children. Moreover, the prospect of the childrearing burden surely bears on the decision-making of women who are delaying marrying, not marrying at all, or remaining childless within marriage. This burden is becoming more salient as Korea is aging and the burden of care-giving to seniors falls heavily on daughters and daughters-in-law.

〈Table 1-5〉 Hours per day spent on household activities, Korea 2004

Age group	Male	Female
0-19	0:08	0:14
20-64	0:51	4:12
65+	1:07	3:25

Conclusions

The impact of demographic change is complex and multi-faceted. It is a product of considerable success in Korea and it offers opportunities as well as challenges. Institutions in Korea are well-advised to improve understanding of the ways aging can be accommodated as well as ways to support families, and particularly women, who are responsible for future generations of Koreans.

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II

Health and Retirement: South Korea, China, and the US

II Health and Retirement: South Korea, China, and the US

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Introduction

The experience of rapid population aging and low fertility rate is of great concern to many governments as it implies an increased dependency burden on the working age population and threatens fiscal sustainability in the field of pension and medical care. With regard to public pension systems, many governments have considered policies to reduce the economic impact of future population aging. One of the pension reforms has been to increase the pension eligibility age For example, the normal retirement age (full retirement age) at which full benefits are payable remained at 65 in the U.S. for many years. However, according to the Social Security Amendments of 1983, beginning with people born in 1938 or later, that age has been gradually increased so that it reaches 67 for people born after 1959. Germany also increased the regular social security retirement age from 65 to 67 years and Spain from 65 to 67

years. Japanenacted a law that imposes constraint firms to employ older workers in 2004 among the following three options; (i) abolishing the mandatory retirement age (60 years), or (ii) raising the mandatory age from 60 to 65, (iii) continued employment. Rapidly aging Koreahas started to discuss the necessity of the extension of retirement age from 60 to 65 years in order to utilize older workers as additional workforces.

On the other hand, the labor force participation rates of the older male workers aged 65 and older has been increasing since 1990s after its long decline until the 1980s (Coile, Milligan, and Wise, 2016a; Oshio et al., 2010). The participation rates for women are also increasing as well. There may be several reasons why the labor force participation of older labor forces increases. For example, several theories have been trying to attribute the increase in participation ratio of older people to improving health conditions, educational attainments, employer-provider benefits, and social security benefit (Coile, 2018).

There are dozens of literature linking social security benefits and retirement decisions (Gruber and Wise, 1999; French, 2005; Coile and Gruber, 2007). However, the relationship between health improvement and work capacity is much less pronounced although the literature is growing. Recently, the International Social Security (ISS) project team of twelve countries has studied the effects of the retirement programs on the labor force participation of older people (Coile, Milligan, and

Wise, 2016).* Using the methodology of Cutler, Meara, and Richards-Shubik (CMR, 2012), Matsukural et al. (2018) also calculate the work capacity of the older people at the national level and showed that there is a substantial work capacity in Japan.

Using the three countries' (Korea, China, and the US) health and retirement studies as well as the National Transfer Accounts (NTA) data sets, this study tries to quantify the potential work capacity of these countries and explain the different results across countries. In addition, we try to estimate the potential improvement of the nation's growth potential (so called economic support ratio, ESR)due to health.

Our central finding is that there are substantial heterogeneities across nations in terms of employing additional older workers. While Korea has relatively small positive effects, USA has enormous room for potential work capacity due to improvement in health. It appears that the discrepancy in productivity between older workers and their younger counterparts is the main reason of Korea's small potential work capacity. Compared with their health status, Korea as well as Chinese older workers are already working more than US older workers. This might be due to two factors. First, pension and public healthcare (Medicare) benefits are more generous in the US compared with Korea or

* So far, the ISS has implemented sixth projects related to the labor force of the elderly, and this is the seventh phase of the project which investigates the health capacity to work at older ages.

China. Second, Korea and Chinses elderly are relatively less productive compared with their younger cohorts, which is not the case for the US. The next section describes the data sets and methodologies. Section 3 compares the estimation results across countries.The last section concludes and provides some implications of this paper.

Data and Methodology

1. Data

This research heavily relies on two types of data sets, the Health and Retirement Studies and the National Transfer Accounts.

1) The Health and Retirement Studies

First, this study's primary data set is the Health and Retirement Study (HRS) of three countries (Korea, China, and the USA) for cross-country study. Notably, we use the harmonized HRS data sets; the Korean Longitudinal Study of Aging (KLoSA), the China Health and Retirement Longitudinal Study (CHARLS) as well as the HRS.

Since the HRS in the United States has achieved remarkable success since the first survey in 1992, other countries also have

been conducting similar studies*. As these surveys follow a similar methodology and questions of the HRS faithfully, the harmonization with HRS of the studies leads to provide remarkable opportunities for cross-country study. However, some differences in questions and collecting data give limitations to conduct empirical studies. As a result of the University of Southern California (USC) program on Global Aging, the Gateway to Global Aging Data (Gateway)**provides the harmonized data across countries. The Gateway provides comparable measures and key harmonized variables across surveys (Harmonized CHARLS documentation, 2018; Harmonized HRS documentation, 2018; Harmonized KLoSA documentation, 2019).

Since the first wave of KLoSA in 2006, the survey has been collecting data every two years, and data of six waves (2016) are available so far. Excluding Jeju Island, the panel sample is a random sample of 10,254 adults aged 45 or older in 15 municipalities, and the fifth wave (2014) added a refreshment sample of 920 people (Users'Guide for the KLoSA, Korean Employment

* Mexican Health and Aging Survey (MHAS), the English Longitudinal Studies of Ageing(ELSA), the Survey of Health, Ageing and Retirement in Europe (SHARE), the Korean Longitudinal Study of Aging (KLoSA), the Japanese Study on Aging and Retirement (JSTAR), the Irish Longitudinal Study on Aging (TILDA), the China Health and Retirement Longitudinal Study (CHARLS), Health and Aging in Africa, the Brazilian Longitudinal Study of Ageing (ELSI), Healthy Ageing in Scotland (HAGIS), the Northern Ireland Cohort Longitudinal Study of Ageing (NICOLA), and the Longitudinal Aging Study in India (LASI).

** Gateway to Global Aging Data is produced by the program on Global Aging, Health and Policy, University of Southern California with funding from National Institute on Aging (R01 AG030153). The Gateway can be accessed at https://g2aging.org/.

Information Service, 2018).

After a pilot study in two poor and rich provinces (Gansu, Zhejiang) in 2008, the CHARLS conducted its national baseline survey in 2011-2012 for older people aged 45 or above and their spouses at all ages. In the baseline survey, they succeed interview of 17,708 respondents in 450 villages in 150 countries/districts, 450 villages/urban communities (2011-2012 National Baseline Users'Guide of CHARLS, 2013). So far, data of the four waves are available. However, since the data of wave three (2014) is about just life history, this study uses three waves of CHARLS (2011, 2013, and 2015).

The HRS is a nationally representative longitudinal study of more than 37,000 people over age 50 and their spouses in the United States. Since the initial cohort in 1992 who were born during1931-1941, the HRS has been adding several cohorts and conducting surveys every two years; the first AHEAD wave (born before 1924) in 1993, the Child of Depression (CODA) cohort (born in 1924-1930) in 1998, the War Baby (WB, born in 1942-1947) in 1998, the Early Baby Boomer (EBB, born in 1948-1953) in 2004, and the Mid Baby Boomer cohort (MBB, born in 1954-1959) in 2010. There are several auxiliary HRS data sets*. Among them, this study uses two types of HRS data sets. First, the Harmonized HRS data provide comparable measures and

* RAND enhanced fat files, RAND HRS Longitudinal data, RAND Family data, Polygenic score data, and so on.

critical variables for cross-country study, and the Harmonized HRS include the first twelve waves (1992-2014) of the HRS and 1993 and 1995 AHEAD cohorts (Harmonized HRS Documentation, October 2018). Second, The RAND HRS containsmost of the original HRS variables with household data merged to the respondent level variables during 1992-2016 (RAND HRS Longitudinal File 2016(V1) Documentation, May 2019). Considering data availability and comparability* with KLoSA and CHARLS, this research combines the Harmonized HRS with the RAND HRS longitudinal data (released May 2019).

2) National Transfer Accounts (NTA)

This research also uses the National Transfer Accounts (NTA), which is the analytical tools developed for analyzing a wide range of socioeconomic and demographic changes caused by age structure change as an international collaborative research project. In the past decades, rapid demographic changes lead to needs for improved understanding of how population structure and changes influence economic consequences such as gender and generational equity, public finances, and financial transfers. Research teams in more than 60 countries have been constructing accounts that measure how people produce, con-

* For example, Harmonized HRS does not include cognitive functioning measure (score of immediate and delayed recall, their serial 7s test), but the RAND HRS includes extensive information including cognitive functioning.

sume, and share resources by age. Since the accounts are designed to be consistent with the UN System of National Accounts (Mason et al., 2017) and contain a wide range of information, the NTA can be a practical analytical tool for measuring economic flows across age groups. A fuller explanation of NTA's concept, NTA data sets by country, basic lectures, and methodology are available on the NTA global project website (http://www.ntaccounts.org).

This study also uses the World Population Prospects 2019 (UN, 2019) for population data over 1950-2100 and the International Labor Organization labor statistics (ILOSTAT, accessed August 2019) for effective producers (i.e., labor force by age). This data will be used to estimate the economic support ratio (ESR).

2. Measuring health capacity to work at older ages

There are two main approaches to measure the health capacity to work at older people. The first is the Milligan-Wise method (MW) based on the study of Milligan and Wise (2015), which uses the relationship between mortality and employment. The MW regards the health capacity to work as a decrease in mortality over the decades. The second approach is the Cutler et al. method (CMR) based on the work of Cutler, Meara, and Richards-Shubik (2012). In the CMR, the work capacity to work is the difference in the actual and predicted employment rates,

in which the predicted employment rate is estimated under the assumption that the relationship between health and employment of the younger is same to that of the elderly (Coile, Milligan, and Wise, 2016a; Coile, Milligan, and Wise, 2016b).

We conduct the country-specific regression of three countries for males aged 50-59 and apply the coefficients of the baseline regression to individual characteristics for older men aged 60-79 in order to measure the additional health capacity, respectively. Since this study aims at quantifying the potential working capacity of the elderly in terms of health status, this paper does not consider other factors on the labor supply decision like wages but to focus on health status as significant factors labor supply of older workers. As an econometric specification, this research employs a country-specific linear probability model (LPM) to regress a binary variable to indicate the labor force participation status, which is equal to 1 if the individual is in the labor market (employed or unemployed) and 0 if the person is not in the labor force. Assume that Y_{it} is the labor force participation propensity given for individual i at survey year t by:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_{it} + c_i + \delta_t + \epsilon_{it}$$

where X_{it} are health status variables of individual i at survey year t, Z_{it} is a set of individual's characteristics, c_i are regional

fixed effects, δ_t are year fixed effects. For measure the health status of the elderly, this study uses the following explanatory variables; (1) self-rated health status (five-point scale: poor, fair, good, very good, excellent), (2) dummy variables*for measuring the prevalence of limitations on activities of daily living (ADL), and limitations on instrumental activities of daily living (IADL), (3) dummy variables of self-report for depressive symptoms based on the Center for Epidemiologic Studies Depression (CESD**), (4) variables measuring cognitive ability***

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* Harmonized HRS, CHARLS, and KLoSA, provide ADL (Wallace and Herzog method, 0-3 points, cut-off is 1 or higher), and IADL (0-5 points, cut-off is 1 or higher). While ADL measures whether there are some difficulties in using bathroom, wearing and taking off dress, and eating., IADL measures some difficulties in using telephone, taking medication, handling money, shopping, and preparing meals.

** CESD measures depressive symptom by asking questions whether a respondent felt depressive symptom during the past week. Whereas KLoSA includes 10-items (range 0-30), and HRS 8-items (range 0-8). Cut-off are set as followings; For KLoSA cut-off≥10 (Andresen et al., 1994), for HRS cut-off≥3 (Turvey et al., 1997),

*** Cognitive ability measures are a little different by data.

(1) HRS scores immediately (0-10) and delayed word recall (0-10), serial 7's (0-5), and backward counting (0-2), total score is ranging 0-27. Using Langa-Weir approach (Langa, Kabeto, and Weir, 2009), cut-off is set as 0-6 (severe impaired), 7-11 (mild impaired), and 12 or higher (normal).

(2) CHARLS scores immediately (0-10) and delayed word recall (0-10), serial 7's (0-5), dates naming (0-4), drawing picture (0-1), season naming (0-1), and total score is ranging 0-31. Following Montreal Cognition Assessment (Saczynski et al., 2015), cut-off isset as 0-9 (severe impaired), 10-17 (mild impaired), and 18 or higher (normal).

(3) KLoSA scores immediately (0-3) and delayed word recall (0-3), serial 7's (0-5), dates naming (0-3), day of week (0-1), naming 1st object(0-1), naming 2nd object(0-1), drawing picture (0-1), repeat sentence (0-1), following direction (0-3), read and close eyes (0-2), and writing (0-1), total score 0-25. Cut-off is set as Langa-Weir approach like HRS, i.e., as 0-6 (severe impaired), 7-11 (mild impaired), and 12 or higher (normal).

(normal, mild impairment, and severe impairment), (5) dummy variables for doctor-diagnosed of chronic diseases (hypertension, diabetes, cancer, lung disease, heart disease, stroke, and arthritis), (6) dummy variable for using hearing aid. In addition to health variables, this study includes demographic, regional factors, and survey years; (7) dummy variable for marital status, (8) education attainment (less than secondary school, upper secondary school or vocational training school, and tertiary school), (9) dummy variable for rural residences, (10) survey regions, (11) survey years, (12) race (only in the USA).

Concerning Economic Support Ratio (ESR), several indexes, for example, dependency ratio* and aging index**, been used to understand the population and age structure's impact on economic growth. Among them, this paper focuses on NTA Economic Support Ratio (ESR) since the NTA ESR incorporates the population age structure and age-specific patterns of production and consumption that compromise the lifecycle (Lee and Mason, 2012; Lee, 2014; Sanderson and Scherbov, 2015; Mason et al., 2017), the NTA support ration would be an appropriate tool for this research. The total output in year t, Y(t), and total consumption in year t, N(t), are defined as, respectively:

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* Dependency ratio = (number of dependents aged zero to 14 + aged of 65+) / (population aged 15 to 64).

** Aging index = (number of youth aged zero to 14) / (number of people aged 65+).

$$Y(t) = \sum_{x=0}^{w} y(x)n(x,t), N(t) = \sum_{x=0}^{w} n(x,t)$$

where $y(x)$ is the labor income per capita by age, $n(x,t)$ is the population aged $x$in year t, $c(x)$ is the consumption per capita by age, N(t) is the total population in year t, $w$is 100 because UN World Population Prospects 2019 provides population data for people aged 0-100. Then, we can calculate the NTA economic support ratio (ESR) as the ratio of the total income to the total consumption.

3. Estimation Results

1) Summary statistics

Table 1 shows the summary statistics of the variables of the three countries used in the estimation for baseline regression. First, look at non-health variables. Labor force participation rates (dependent variable) are different by countries. While the labor force participation rates are higher in Korea and China than the USA (Korea 88.4%, China 87.7%, and the USA 80.0%). As for educational attainment, while the most substantial proportions of China are graduates of less than a secondary school (76.6%), most of the respondents in the USA are graduates of secondary school or above (84.6%). The USA shows the lowest marital status rate (72%). Most respondents'race in the USA is

white (72.9%), black (17.6%), and other (9.5%).

Second, health variables show considerable amounts of variations across countries. Concerning self-rated health status, while Koreans and the USA citizens are likely to think that their health conditions are poor and fair (Korea 10.3%, the USA 24.0%), the ratio of China is much higher (68.1%). About CESD, ADL, and IADL, the Chinese are likely to feel depression symptoms (CESD) and have limitations of daily activities (ADL, IADL) than other countries' people. Measures cognitive ability show that about 2/3 of Chinese respondents seem to have cognitive impairments. For chronic diseases, Chinese and the USA people are more likely to be diagnosed as having chronic diseases than Koreans. Hypertension and arthritis seem most common among the elderly in China and the USA.

〈Table 2-1〉 Summary Statistics (males aged 50-59)

	(1) Korea		(2) China		(3) USA	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Employed(1=in the labor force, 0=not)	0.8864	0.3173	0.8770	0.3285	0.7998	0.4002
Age	54.8245	2.7306	54.5693	2.9533	55.5405	2.5134
Education						
(less than secondary school)	0.2500	0.4330	0.7656	0.4237	0.1543	0.3612
(upper secondary school)	0.5163	0.4998	0.2050	0.4037	0.5721	0.4948
(tertiary school)	0.2337	0.4232	0.0295	0.1691	0.2736	0.4458
Race						
(White)					0.7288	0.4446
(Black)					0.1759	0.3807
(Other)					0.0953	0.2937
Currently married	0.9228	0.2669	0.8628	0.3441	0.7224	0.4478
Self-Rated Health Status						
(poor)	0.0170	0.1294	0.1683	0.3741	0.0713	0.2573
(fair)	0.0860	0.2804	0.5132	0.4999	0.1690	0.3748

	(1) Korea		(2) China		(3) USA	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
(good)	0.3115	0.4631	0.1776	0.3822	0.3015	0.4589
(very good)	0.5375	0.4986	0.1284	0.3345	0.3109	0.4629
(excellent)	0.0480	0.2137	0.0126	0.1113	0.1473	0.3544
CESD (1=depressed)	0.1531	0.3601	0.2538	0.4352	0.2064	0.4048
ADL (1=having limitations)	0.0123	0.1103	0.0481	0.2141	0.0841	0.2775
IADL (1=having limitations)	0.0967	0.2956	0.1171	0.3216	0.0954	0.2938
Cognition Ability						
(normal)	0.9542	0.2090	0.3292	0.4699	0.8046	0.3965
(mild impairment)	0.0036	0.0601	0.4463	0.4971	0.1049	0.3064
(severe impairment)	0.0421	0.2009	0.2246	0.4173	0.0905	0.2869
Hearing Aid (1=yes)	0.0282	0.1657	0.0041	0.0636	0.0291	0.1680
Chronic Diseases						
Hypertension (1=yes)	0.1943	0.3957	0.2468	0.4312	0.4288	0.4949
Diabetes (1=yes)	0.1016	0.3022	0.0690	0.2535	0.1590	0.3657
Cancer (1=yes)	0.0147	0.1203	0.0085	0.0916	0.0464	0.2103
Lung disease (1=yes)	0.0101	0.1000	0.1136	0.3174	0.0450	0.2074
Heart disease (1=yes)	0.0271	0.1625	0.0973	0.2964	0.1323	0.3388
Stroke (1=yes)	0.0221	0.1470	0.0235	0.1516	0.0392	0.1942
Arthritis (1=yes)	0.0327	0.1778	0.3222	0.4674	0.3269	0.4691
Region type1 (1=rural)	0.1666	0.3727	0.5842	0.4929	0.2735	0.4458
Region type2						
(Seoul)	0.1395	0.3465				
(Busan)	0.0986	0.2982				
(Daegu)	0.0592	0.2360				
(Incheon)	0.0374	0.1898				
(Gwangju)	0.0497	0.2174				
(Daejeon)	0.0560	0.2300				
(Ulsan)	0.0417	0.1998				
(Gyeonggi)	0.1725	0.3778				
(Gangwon)	0.0439	0.2048				
(Chungbuk)	0.0347	0.1831				
(Chungnam)	0.0499	0.2177				
(Jeonbuk)	0.0372	0.1894				
(Jeonnam)	0.0440	0.2052				
(Gyeonhbuk)	0.0630	0.2429				
(Gyeongnam)	0.0727	0.2597				
(Agricultural hukou)			0.7600	0.4271		
(Non-agricultural hukou)			0.2268	0.4188		
(Unified residence hukou)			0.0130	0.1135		
(Do not have hukou)			0.0001	0.0121		
(Northeast)					0.1484	0.3555
(Midwest)					0.2412	0.4278
(South)					0.3909	0.4880

	(1) Korea		(2) China		(3) USA	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
(West)					0.2190	0.4136
(Other)					0.0006	0.0235
Obs.						
2006	1,311					
2008	1,157					
2010	1,073					
2012	936					
2014	1,128					
2016	732					
2011			2,093			
2013			2,195			
2015			2,645			
1998					2,451	
2000					1,788	
2002					1,050	
2004					2,045	
2006					1,595	
2008					1,299	
2010					1,994	
2012					2,225	
2014					1,799	

Notes: Calculated by the author using KLoSA (Korea), CHARLS (China), and HRS (USA) for people aged 50-59.

2) Baseline regression results for health capacity to work

Table 2reports the estimation results of the probability of the labor force participation rate by three countries. For education attainment, education gradients are more significant in the USA than other countries, i.e., the coefficients of the USA indicate thatthe graduates of upper secondary school or tertiary school are more likely to be in the labor market compared with those of less than secondary school (reference group). People who live with a partner (or spouse) are more likely to join the labor

market than the non-married couples in all three countries. While Chinese rural residents tend to work more than counterparts in the urban area, Korea and USA citizens in rural are less likely to work than their urban counterparts. It is also interesting to note that the probability of labor force participation has been increasing over time in Korea, but there is no consistent pattern in the USA.

Regarding the health gradients, the estimated results of the self-health status show that good health tends to have substantial positive impacts on the probability of working, it implies that the health gradient is one of the most critical determinants for participation in the labor market for old workers. People who responded to a question on self-health status to be good are more likely to be in the labor force compared with people having poor health (reference group) for all countries as expected. For example, Korean people with excellent health status are more likely to increase the probability of working by 39.6 percentage points than people with poor health. CESD, ADL, IADL show negative coefficients for all cases, and it implies that adverse health conditions tend to decrease working probability. For instance, the USA residents who have some problems in preparing for meals, which is one of the measures in limitations on instrumental activities of daily living (IADL), tend to work less by 13.8 percentage points compared with people who do not have any difficulty in IADL. In terms of cog-

nitive ability, it is interesting to note that most of the coefficients report negative impacts on working possibility, and the results are more substantial in the USA than those of two countries. The USA males with having severe cognitive impairment are less likely to be in the labor force by 18.1 percentage points than males with normal cognitive ability. Concerning chronic diseases, people who reported to have chronic diseases are less likely to be in the labor force than those who have not the diseases. The coefficients of severe illnesses like cancer, stroke show adverse impacts on the labor force participation rate as expected. Korean who are diagnosed to have a stroke are likely to decrease the probability of joining the labor market by 10.1 percentage points compared with people whohave not a stroke. However, there are some differences between the three countries. For example, while Chinese with arthritis are likely to work more than counterparts, Korean and USA residents are less likely to work more.

〈Table 2-2〉 Dependent variable: Binary variable for labor force participation rate (0=no, 1=Yes)

	(1) Korea	(2) China	(3) USA
Education			
less than secondary(ref.)	-	-	-
upper secondary	0.005	-0.013	0.022*
	(0.009)	(0.018)	(0.012)
Tertiary	-0.005	0.054***	0.059***
	(0.012)	(0.016)	(0.014)
Race			
White(ref.)	-	-	-

	(1) Korea	(2) China	(3) USA
Black			-0.057***
			(0.011)
Other			0.002
			(0.013)
Currently married(1=married)	0.083***	0.062**	0.056***
	(0.011)	(0.024)	(0.008)
Self-Rated Health Status			
poor (ref.)	-	-	-
Fair	0.192***	0.095***	0.201***
	(0.073)	(0.022)	(0.027)
Good	0.344***	0.123***	0.275***
	(0.074)	(0.027)	(0.027)
very good	0.382***	0.123***	0.316***
	(0.075)	(0.027)	(0.028)
excellent	0.396***	0.117***	0.340***
	(0.076)	(0.041)	(0.029)
CESD (1=depressed)	-0.031***	-0.001	-0.020**
	(0.009)	(0.015)	(0.009)
ADL (1=having limitations)	-0.093***	-0.104***	-0.102***
	(0.027)	(0.019)	(0.012)
IADL (1=having limitations)	-0.026**	-0.049***	-0.138***
	(0.012)	(0.014)	(0.012)
Cognition Ability			
normal (ref.)	-	-	-
mild impairment	-0.146	0.014	-0.057***
	(0.135)	(0.018)	(0.013)
severe impairment	-0.001	-0.012	-0.181***
	(0.019)	(0.022)	(0.045)
Chronic Diseases			
Hypertension (1=yes)	0.003	0.019	-0.011
	(0.010)	(0.014)	(0.008)
Diabetes (1=yes)	-0.022**	-0.078***	-0.007
	(0.010)	(0.025)	(0.009)
Cancer (1=yes)	-0.025	-0.086**	-0.050***
	(0.023)	(0.037)	(0.014)
lung disease (1=yes)	0.070**	0.015	-0.037**
	(0.028)	(0.017)	(0.015)
heart disease (1=yes)	0.008	-0.009	-0.053***
	(0.021)	(0.016)	(0.009)
Stroke (1=yes)	-0.101***	-0.061**	-0.100***
	(0.018)	(0.025)	(0.017)
Arthritis (1=yes)	-0.029*	0.011	-0.044***
	(0.016)	(0.019)	(0.007)
Hearing Aid (1=use)	0.034**	-0.096	-0.066***
	(0.016)	(0.090)	(0.023)

	(1) Korea	(2) China	(3) USA
Residence type 1 (1=rural)	-0.029**	0.090***	-0.019**
	(0.014)	(0.020)	(0.008)
Residence type 2			
Seoul(ref.)	-	-	-
Busan	0.037**		
	(0.015)		
Daegu	0.037**		
	(0.017)		
Incheon	-0.016		
	(0.029)		
Gwangju	0.022		
	(0.021)		
Daejeon	0.014		
	(0.022)		
Ulsan	0.069***		
	(0.014)		
Gyeonggi	0.026*		
	(0.014)		
Gangwon	0.042**		
	(0.019)		
Chungbuk	0.010		
	(0.024)		
Chungnam	-0.010		
	(0.027)		
Jeonbuk	0.022		
	(0.021)		
Jeonnam	0.057***		
	(0.016)		
Gyeongbuk	-0.006		
	(0.022)		
Gyeongnam	0.042***		
	(0.016)		
Agricultural hukou (ref.)	-	-	-
Non-agricultural hukou		-0.106***	
		(0.025)	
Unified residence hukou		0.010	
		(0.033)	
Northeast (ref.)	-	-	-
Midwest			0.009
			(0.012)
South			0.009
			(0.011)
West			0.024**
			(0.012)

	(1) Korea	(2) China	(3) USA
Survey Years			
2006 (ref.)	-	-	-
2008	0.023*		
	(0.013)		
2010	0.030**		
	(0.013)		
2012	0.035***		
	(0.013)		
2014	0.038***		
	(0.014)		
2016	0.048***		
	(0.016)		
2011 (ref.)	-	-	-
2013		0.004	
		(0.020)	
2015		0.022	
		(0.017)	
1998 (ref.)	-	-	-
2000			-0.028**
			(0.014)
2002			-0.059***
			(0.019)
2004			0.008
			(0.012)
2006			-0.013
			(0.014)
2008			-0.028*
			(0.016)
2010			0.009
			(0.013)
2012			0.009
			(0.012)
2014			0.006
			(0.014)

Notes: Robust standard errors in parentheses. *, **, and *** indicate statistical significance at the 10, 5, 1 percent level, respectively.

3) The potential health capacity to work of the elderly

On the bases of the estimated coefficients for those aged 50-59, we attempt to simulate the untapped health capacity to

work for people aged 60-79, i.e., this study predicts values for each individual in KLoSA, CHARLS, and HRS and averages for eachage, respectively. Then, we regard the potential work capacity as the slack between the actual and the predicted labor force participation probability. This method assumes that the relationship between health and labor force participation rate is the same for two age groups.

Table 3shows that the predicted work capacities of the three countries. By and large, for all people aged 60-79, the capacity increases with age, and the slacks are substantial in the USA compared to Korea and China. From 9% at age 60, the slack reaches 49% at age 79 in the USA, and the amounts of the potential capacity calculated using the size of the population at each age in 2014 ranges from 177 to 295 ten thousand people in the USA. Second, the differences between actual and predicted probabilities are relatively small in Korea and China, and it may imply that the old male workers in Korea and China are more likely to work than the elderly of the USA in terms of health status; the slack in Korea increases with age from 9% at age 60 to 43% at age 78 and decreases to 40% at age 79, and the slack ranges from 5% to 50% in China. Considering the numbers of the elderly aged 60-79 in Korea, China, and the USA, the estimated total amounts of potential work capacity are 897 (Korea), 19,581 (China), and 8,159 (USA) ten thousand people, which are about 23 percent (Korea), 21 percent (China), and 33

percent (USA) as the percentages of total population for those aged 60-79, respectively.

〈Table 2-3〉 Additional health capacity to work (Male)

Age	Korea				China				USA			
	Predicted (%)	Actual (%)	Slack (%)	work capacity	Predicted (%)	Actual (%)	Slack (%)	work capacity	Predicted (%)	Actual (%)	Slack (%)	work capacity
60	0.88	0.79	-0.09	30.24	0.86	0.81	-0.05	394.80	0.78	0.69	-0.09	177.69
61	0.86	0.77	-0.09	29.03	0.84	0.77	-0.07	597.82	0.77	0.68	-0.09	165.03
62	0.86	0.75	-0.12	33.13	0.85	0.73	-0.11	939.07	0.78	0.57	-0.21	381.82
63	0.86	0.75	-0.11	29.35	0.84	0.71	-0.14	1,078.57	0.77	0.49	-0.28	475.40
64	0.86	0.69	-0.17	41.71	0.84	0.69	-0.15	1,082.16	0.77	0.43	-0.33	552.37
65	0.84	0.65	-0.19	45.22	0.83	0.68	-0.15	975.94	0.77	0.45	-0.32	511.13
66	0.83	0.65	-0.18	39.34	0.85	0.69	-0.16	908.35	0.76	0.42	-0.35	526.34
67	0.83	0.58	-0.25	51.55	0.83	0.61	-0.22	1,094.80	0.76	0.37	-0.39	561.87
68	0.82	0.57	-0.25	49.45	0.84	0.61	-0.22	993.13	0.75	0.40	-0.35	463.29
69	0.82	0.54	-0.28	52.94	0.83	0.51	-0.32	1,349.22	0.74	0.28	-0.45	555.10
70	0.81	0.51	-0.30	53.48	0.82	0.54	-0.28	1,080.86	0.74	0.40	-0.34	378.19
71	0.80	0.47	-0.33	56.69	0.82	0.54	-0.27	977.00	0.73	0.34	-0.39	404.46
72	0.78	0.44	-0.35	56.10	0.81	0.53	-0.28	925.45	0.72	0.32	-0.40	388.47
73	0.77	0.45	-0.32	49.21	0.79	0.52	-0.27	820.08	0.72	0.27	-0.45	411.15
74	0.77	0.40	-0.37	52.85	0.79	0.44	-0.35	998.05	0.71	0.21	-0.49	425.85
75	0.77	0.39	-0.38	50.27	0.80	0.35	-0.45	1,180.99	0.70	0.23	-0.48	387.21
76	0.77	0.36	-0.41	50.97	0.77	0.28	-0.50	1,211.79	0.69	0.19	-0.50	385.14
77	0.73	0.35	-0.38	43.85	0.80	0.29	-0.50	1,131.38	0.67	0.15	-0.52	367.05
78	0.75	0.32	-0.43	45.00	0.78	0.31	-0.47	957.63	0.67	0.14	-0.53	346.46
79	0.73	0.33	-0.40	36.87	0.81	0.31	-0.50	883.94	0.64	0.15	-0.49	295.04

Notes: Actual labor force participation rates by age are calculated by the author using current population survey microdata in 2016 (Korea), CHARLS in 2015 (China), and HRS in 2014 (USA), respectively. The work capacity (unit: ten thousand people) of each country calculated by the author using UN World Population Prospect 2019 of corresponding year data by age, i.e., Korea (2016), China (2015), and the USA (2014).

The slacks of females in Korea and China are smaller than those of males. However, in the USA, the untapped female workers' capacity is similar to male workers, which may result from the social atmosphere toward gender equality*compared with Asian countries; the discrepancy between males and females in educational attainments may be one evidence that gender inequality is more substantial in Korea and China than in the USA. It is worth mentioning that the slacks of Korean females, unlike China and the USA, are positive for those aged 60-62 and 64, presumably in part, which may reflect that there are more job opportunities for Korean females in their early 60s than males**. However, considering the difficulty in interpretation of the results for women's case, we do not report the female's case.

4) The Economic Support Ratio (ESR)

By using the computed results of the health capacity, this section attempts to quantify the additional workers into an economic outcome. First, we include theage-specific additional

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* Gender inequality in Asian countries are well documented (for example, Steel, Gill, and Kabashima, 2008)

** For example, according to Korean Aged Employment Status Survey in 2016, the percentages of desired monthly wages of females are lower than males; most males want more than $1,500 at a month, on the other hand, most females'desired monthly wages are $500-$1,000. In addition, considering there are more self-employed people such as restaurants in Korea than other countries, there may be more job opportunities like waitress.

workers (slacks computed previous section) into the total population for people aged 60-79 to from 2014 or 2015 or 2016 to 2100*. Second, we calculate the economic support ratio (ESR) under the assumption that an individual's age-specific consumption and labor income profiles of the National Transfer Account (NTA) of each country remain unchanged**.

Figure1 shows the original ESR and the predicted ESR for the years 1950 ~ 2100 for Korea, China, the US, and Japan. In Korea, while theoriginal ESR had increased from 0.8061 in 1966 to 1.2402 in 2014 and started to decrease since 2014, the estimated ESR reached its peak in 2016 (ESR 1.2491) and began to decrease after 2016. In the case of China, since the original ESR had increased during the years from 1972 (ESR 1.4017) to 2012, the ESR decreases continuously after 2012. The additional health capacity makes it reach its peak in 2015. The cases of the USA and Japan show a similar trend to the Korea and China cases. While the original ESR of the USA had started to increase around 1971 (ESR 0.9603), the peak reached in 2015. The predicted ESR resulted from the additional older workers are also 2015. In Japan***, since the original ESR had increased

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* Considering the data availability in estimating health capacity, we set different year to add the untapped workers; Korea (2016-2100), China (2015-2100), and the USA (2014-2100).

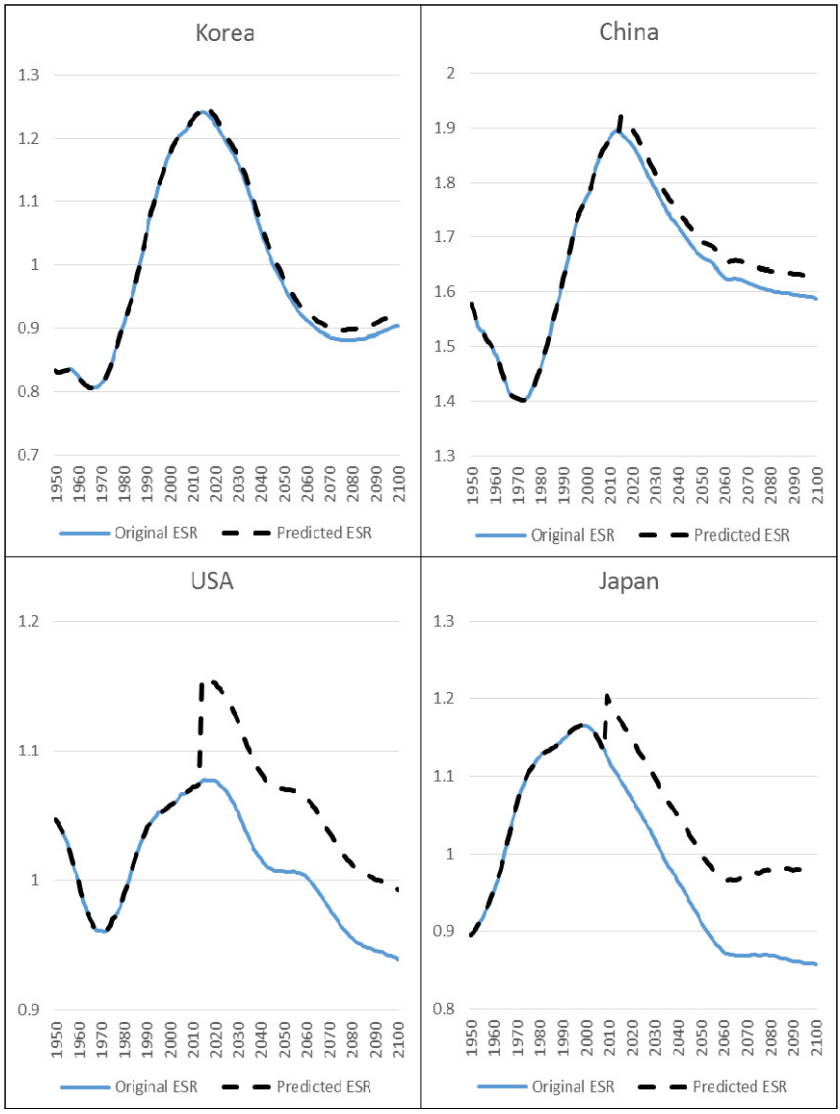
** Moreover, we calculate the effective workers using labor force data in ILO because NTA only provides per capita income.

*** Japan is not the primary research country, this paper includes the Japan as the reference. We modify the Matsukura et al. (2018) to refer to the Japan case.

steadily to 1999, its trend had decreased continuously. The additional work capacity of Japan leads to its peak in 2009 (predicted ESR 1.2034).

Although there are substantial health capacities to work in all four countries, the additional magnitudes of the increased ESR, which is defined as the differences between the original ESR and the predicted ESR, are different across countries. Among the three countries (Korea, China, and the USA), while the total amounts of the increase in the predicted ESR is the highest in the USA, those of Korea is the smallest; the increase in the total income of the USA for 2014-2100 is 6.3 percentage, that of Korea is the 1.3 percentage for 2016-2100, that of China is 1.9 percent, and the additional total income of Japan is 9.7 percent.

[Figure 2-1]. Economic Support Ratio (ESR): Original vs. Predicted ESR

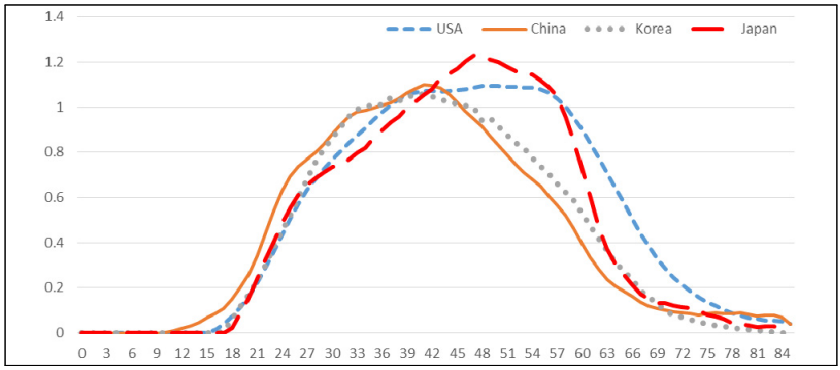


Notes: ESRs of each country are calculated by the author using NTA data in 2012 (Korea), 2002 (China), and 2011 (USA), respectively.

There may be several explanations of why there are considerable differences in the untapped work capacities of older workers across countries. Among them, this paper focuses on two factors; first, we examine whether there are individuals' age-specific productivity differences and investigate whether there are other reasons through the decomposition analysis.

First, this paper examines the differences in the individuals' productivity of the elderly in three countries. As the individual's productivity tends to decrease since their late 30s (Rhee et al., 2011), the lower productivity of older people compared with that of younger counterparts may lead to differences in the magnitudes of the additional ESRs. So, if the individual productivity of the elderly in the USA is more significant than in other countries, the additional economic impacts may be higher than others. Figure 2 shows one possibility of why there are more substantial capacities in the USA and Japan than other nations because the productivities ofolder workers (aged 50+) in the USA and Japan are much higher than those of Korea and China.

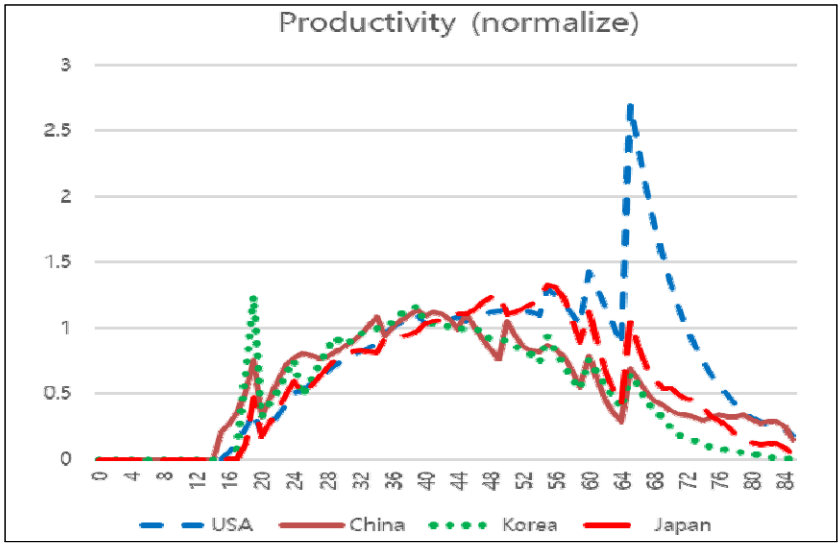
[Figure 2-2] Labor income per capita by age (normalized)



Notes: Age-specific labor incomes are normalized by the average income for those aged 30-49 by the author using NTA data in 2012 (Korea), 2002 (China), and 2011 (USA), respectively.

According to the results on the potential work capacity (ESR), Korea may have not a large health capacity than other countries. There might be several reasons, but among them the low productivity of the older workers in Korea might be the reason for low improvement ofESR for Korea. Using the NTA data, we estimate the per worker productivity and normalized them by using the 30-49 years old workers. The Figure 3 shows the result. As we can see clearly, the productivity of older workers in Korea is relatively lower than other countries. There might be other institutional reasons, which are beyond the scope of this study. We left this for future work.

[Figure 2-3] Per worker productivity by age (normalized)



4. Policy implications

The results show that Korea may have not a large potential work capacity compared with other countries. The United States has enormous room for potential work capacity due to improvement in health, which means that older workers in the US are more likely to retire after 65 due to other reasons, such as pension and Medicare benefit. It also appear that Korea and Chinses elderly are relatively much less productive compared with their younger cohorts, which is not the case for the US. Concerning the productivity issue, we recommend two-tier approaches for labor market reforms for older workers in Korea.

First, for those who have relatively high productivity or ability, it is necessary to strengthen re-training programs for improvement in productivity.

Since there are few formal retraining programs for middle-aged retirees in Korea (Son, 2015), employment promotion policies for the aged should accompany tailored reeducation programs. Second, it may be better to extend social safety nets for those who have not the ability to work more, such as the disabled.

Moreover, removing the labor market rigidity may be a pivotal determinant to improve individual productivity rather than an extension of the retirement age, which is one of the policy agendas for rapid demographic changes. For example, it is critical to reform the wage-system through the extensive introduction of the peak-wage system, and the transition from the seniority-based income to performance-based income system.

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〈Appendix Table 1〉 Logit regression of labor force participation (0=no, 1=Yes)

	(1) Korea	(2) USA	(3) USA
Education			
less than secondary(ref.)	-	-	-
upper secondary	-0.003	0.022**	0.014
	(0.010)	(0.010)	(0.009)
tertiary	-0.009	0.049***	0.036***
	(0.012)	(0.011)	(0.010)
Race			
White(ref.)	-	-	-
Black		-0.047***	-0.034***
		(0.009)	(0.008)
Other		0.012	0.010
		(0.010)	(0.010)
Currently married(1=married)	0.128***	0.064***	0.047***
	(0.019)	(0.007)	(0.007)
Self-Rated Health Status			
poor(ref.)	-	-	-
fair	0.222***	0.201***	0.160***
	(0.049)	(0.018)	(0.017)
good	0.402***	0.282***	0.221***
	(0.048)	(0.018)	(0.017)
very good	0.433***	0.306***	0.239***
	(0.048)	(0.018)	(0.017)
excellent	0.449***	0.314***	0.252***
	(0.050)	(0.019)	(0.018)
CESD (1=depressed)	-0.043***	-0.021**	-0.022**
	(0.013)	(0.009)	(0.009)
ADL (1=having limitations)	-0.217***	-0.161***	-0.119***
	(0.052)	(0.016)	(0.015)
IADL (1=having limitations)	-0.024	-0.191***	-0.126***
	(0.015)	(0.015)	(0.014)
Cognition Ability			
normal (ref.)	-	-	-
mild impairment	-0.209*	-0.047***	-0.029***
	(0.110)	(0.011)	(0.011)
severe impairment	-0.005	-0.149***	-0.110***
	(0.018)	(0.029)	(0.026)
Chronic Diseases			
hypertension(1=yes)	0.006	-0.019***	-0.017***
	(0.011)	(0.006)	(0.006)
diabetes(1=yes)	-0.046***	-0.014	0.001
	(0.015)	(0.009)	(0.009)
cancer(1=yes)	-0.027	-0.040***	-0.038***
	(0.041)	(0.015)	(0.014)

	(1) Korea	(2) USA	(3) USA
lung disease(1=yes)	0.051	-0.080***	-0.043**
	(0.043)	(0.018)	(0.017)
heart disease(1=yes)	0.025	-0.064***	-0.044***
	(0.028)	(0.010)	(0.010)
stroke(1=yes)	-0.209***	-0.128***	-0.092***
	(0.041)	(0.020)	(0.019)
arthritis(1=yes)	-0.063**	-0.044***	-0.026***
	(0.028)	(0.007)	(0.006)
Hearing Aid(1=use)	0.031	-0.082***	-0.053***
	(0.019)	(0.020)	(0.019)
Residence type 1(1=rural)	-0.017	-0.017**	-0.010
	(0.012)	(0.007)	(0.006)
Pension (1=recipient)	-0.208***	-0.439***	-0.235***
	(0.036)	(0.018)	(0.020)
Medicare (1=recipient)			-0.487***
			(0.013)
Constant	0.345***	0.556***	0.645***
	(0.051)	(0.023)	(0.022)
Residence type 2			
Seoul(ref.)	-	-	-
Busan	0.043***		
	(0.015)		
Daegu	0.051***		
	(0.017)		
Incheon	0.005		
	(0.025)		
Gwangju	0.028		
	(0.019)		
Daejeon	0.023		
	(0.018)		
Ulsan	0.062***		
	(0.017)		
Gyeonggi	0.037***		
	(0.014)		
Gangwon	0.069***		
	(0.021)		
Chungbuk	0.015		
	(0.023)		
Chungnam	0.009		
	(0.022)		
Jeonbuk	0.034		
	(0.021)		
Jeonnam	0.081***		
	(0.020)		

	(1) Korea	(2) USA	(3) USA
Gyeongbuk	-0.003		
	(0.020)		
Gyeongnam	0.045**		
	(0.018)		
North East (ref.)	-	-	-
Midwest		0.013	-0.002
		(0.010)	(0.009)
South		0.025***	0.020**
		(0.009)	(0.008)
West		0.029***	0.020**
		(0.010)	(0.009)
Survey Years			
2006 (ref.)	-	-	-
2008	0.024*		
	(0.012)		
2010	0.037***		
	(0.012)		
2012	0.039***		
	(0.013)		
2014	0.042***		
	(0.013)		
2016	0.052***		
	(0.014)		
1998 (ref.)	-	-	-
2000		-0.014	-0.014
		(0.011)	(0.010)
2002		-0.035**	-0.030**
		(0.014)	(0.013)
2004		0.016	0.014
		(0.010)	(0.010)
2008		0.003	-0.002
		(0.012)	(0.011)
2010		0.025**	0.025**
		(0.010)	(0.010)
2012		0.010	0.014
		(0.010)	(0.009)
2014		0.011	0.017*
		(0.011)	(0.010)

III

Japan's "New Orange Plan" and the Changing Cognitive Abilities of the Elderly

III Japan's "New Orange Plan" and the Changing Cognitive Abilities of the Elderly

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Abstract

This paper analyzes the impact of rapid population aging upon the increase of older adults suffering from dementia in the recent past as well as over the next few decades in Japan. In the first half of the paper, we focus our attention on the evolution of dementia care policies with particular emphasis on the "New Orange Plan" implemented in 2015 by the Japanese government. In this Plan, a long-term projection of aged persons with dementia was prepared as a basic input for formulating a host of programs and policy measures. The number of dementia patients is projected to increase at an alarming rate from 4.64 million in 2012 to 7.44 million in 2030. In the second half of the paper, because an overwhelming majority of dementia patients have been suffering from Alzheimer's disease in contemporary Japan, and an impaired memory is a critical factor in predicting whether or not a patient is likely to pro-

ceed to Alzheimer's disease, we quantitatively examine the performance level of cognitive functioning among the older persons on the basis of micro-level data gathered from those aged 50-79. By drawing upon the computed results, we briefly discuss to what extent the Japanese government's long-term projection of the number of old patients with dementia are dependable and realistic.

Introduction

In this paper, we deal with Japan's rapid population aging and its impact on the phenomenal growth of older adults suffering from dementia in recent years. In the first half of this paper, we direct our attention to the evolution of the policies intended to cope with dementia patients, with particular emphasis on the "New Orange Plan" implemented in 2015 by the government. In this Plan, the number of dementia patients was projected from 2012 to 2060, and the projected results provided a base for formulating a wide range of programs and measures to extend support to the patients as well as their caregivers.

In the second half of this paper, because an overwhelming majority of dementia-affected patients in contemporary Japan have been suffering from Alzheimer's disease, and an impaired

memory is a critical factor in predicting whether or not a patient is likely to proceed to develop Alzheimer's disease, we quantitatively examine the performance level of cognitive functioning among Japanese old persons on the basis of micro-level data gleaned from those 50 and 79 years old. Moreover, by drawing upon the estimated regression results, we briefly discuss to what extent the Japanese government's long-term projection are reliable.

Japan's Fast Population Aging and Slower Economic Growth Performance

Over the past half century, Japan has been the most rapidly aging nation in the world. Right after the turn of the century it also became the most aged society. In addition, since 2008, Japan's total population has been continuously diminishing, and this declining trend is expected to last throughout the 21st century (United Nations, 2019).

In Japan, population aging has already imposed great financial pressures on the social security system, including the public health insurance plan andthe long-term care insurance scheme, and these pressures are forecast to grow at an accelerating rate in the coming years. Unfortunately, since the bursting of the bubble economy in the early 1990s, the growth

performance of the Japanese economy has been anemic. Primarily due to the government's delayed policy responses to a series of economic difficulties arising due to both domestic and external factors, by 2018 the government debt accumulated to the level of approximately 2.4 times the country's GDP, which is the highest in the entire world.

While the country's economic growth has been sluggish over the past three decades, the national medical expenditure has been growing at a swift tempo: the ratio of the national medical expenditure to the GDP rose from 4.6 percent in 1990 to 7.9 percent in 2015 (Japanese Ministry of Health, Labour and Welfare, 2018). One of the principal factors accounting for the substantial increase in the medical care costs is the aging of the elderly population. The proportion of those aged 75 and over among those at 65 and over rose from 40.9 percent in 2000 to 48.2 percent in 2015. More importantly, by 2025, it is expected to increase to as much as 59.3 percent, because the postwar baby boomers born during 1947-49 will enter the age group 75 and over in the early 2020s.

The Evolution of Dementia Policies in Japan

As a result of such marked compositional shifts of the elderly population, the number of older adults suffering from dementia has increased dramatically in the past 15 years. In view of this newly-emerging trends in the number of aged patients with dementia, in 2013 the Japanese government announced the "Orange Plan", under which a comprehensive package of measures to tackle dementia was formulated and implemented on astep-by-step basis. In 2015, however, one of the studies commissioned by the Japanese Ministry of Health, Labour and Welfare produced an alarming long-term projection of the number of dementia sufferers aged 65 and over for the period 2012-2060. According to the study, their number is projected to grow by 1.6 times from 2012 to 2030. The government immediately responded by replacing the "Orange Plan" with an upgraded and expanded version called the "New Orange Plan", which relies heavily on the utilization of integrated community care systems. Subsequently, in June 2019, in order to further strengthen the country's dementia care policies, the Ministerial Council on the Promotion of Policies for Dementia Care set up the Framework for Promoting Dementia Care, which emphasized the social inclusion and prevention of dementia. In addition, in October 2019, the G20 Health Ministers'Meeting was organized in Okayama city, and produced the Okayama

Declaration, in which dementia was given high priority as one of the very serious health and social care crises of the 21st century.

The "New Orange Plan": Policy Goals and Programs

In this section, we will review the objectives and scope of the "New Orange Plan". The plan aims to develop dementia-friendly communities in hope of helping persons with dementia continue to live in the spaces and environment they are familiar with as long as possible. To create such communities, the government is focusing on the following seven program areas:

(ⅰ) raising nationwide awareness of dementia and spreading knowledge regarding it in communities,

(ⅱ) providing healthcare and long-term care services in a timely and appropriate manner to those suffering from dementia as they progress through the stages of illness,

(ⅲ) reinforcing measures for tackling with early-onset dementia cases,

(ⅳ) supporting dementia caregivers,

(ⅴ) building communities that are friendly to older adults with or without dementia, and providing them with opportunities for employment and other social activities,

(ⅵ) promoting the research and the development of methodology concerning the prevention, diagnosis and curing of

dementia, rehabilitation and care models for dementia , as well as disseminating the results for wider use,

(vii) broadening the perspectives of dementia sufferers and their families by having them participate in meetings on dementia organized by the central and local governments.

Several of the aforementioned program areas are worth further description. For instance, one of the components of the program area (i) is the nationwide training of the so-called "dementia supporters", whose task is to help dementia patients and their families in local communities. Since the training course is short and frequently organized in many administrative districts, the government has an ambitious goal of producing a total of 12 million dementia supporters by 2020. They wear orange bracelets as their distinctive insignia, as shown in Figure 1. The backdrop behind the selection of orange color is the fact that the so-called "red painted porcelain", which is in fact orange in color and was made in the Edo Period by the potter Kakiemon Sakaida, who was inspired by Japanese persimmon, is widely accepted abroad. The "Orange Plan" and the "New Orange Plan were given those names in the hope that the strategy of the Japanese government for dealing with dementia-related issues which was put forth in them will also become widely accepted by foreign countries which will have to deal with population aging in the future.

[Figure 3-1] Dementia Supporter's Bracelet

NEW ORANGE BRACELET

Three donkeys are engraved on the bracelet-they are the commanders of the dementia supporters' "caravan", who lead it on the path towards "the creation of friendly environments in which people can live with peace of mind even if affected by dementia". The idea behind the choice of the donkey mascot was that the caravan should move, like donkey, without hurrying and with a steady pace.

In connection with the program area (ii), courses for training dementia support doctors have been organized in various administrative districts to expand the human resource base and produce as many as 75,000 dementia support doctors by 2020. In addition, this program area includes establishing at least one medical center for dementia in each designated zone with qualified medical professionals capable of handling the initial-phase intensive care.

The program area (iv) is based on a unique approach. The so-called "dementia cafés" are a part of it, and virtually all the community care centers located in 1724 administrative districts across the country are expected to start offering café-based events on a regular basis by 2020. These establishments are also called "orange cafés". As depicted n Figure 2, they are envis-

aged as familiar venues where persons affected by dementia and their families can come together with local residents, dementia supporters and nursing, welfare and medical specialists to share information and exchange opinions over a cup of coffee.

[Figure 3-2] Dementia café

During the daytime


In the evening

Long-term Projection Providing a Base for the "New Orange Plan"

As briefly mentioned in the previous section, the "New Orange Plan" was formulated by taking into account numericalresults produced in the long-term projection of the number of dementia sufferers aged 65 and over from 2012 to 2060 by Ninomiya, Kiyohara and Ohara. The projection was prepared by drawing upon the data from the five rounds of the Dementia Survey conducted in 1985, 1992, 1998, 2005 and 2012 on a sample which consisted of all the inhabitants of the rural town of

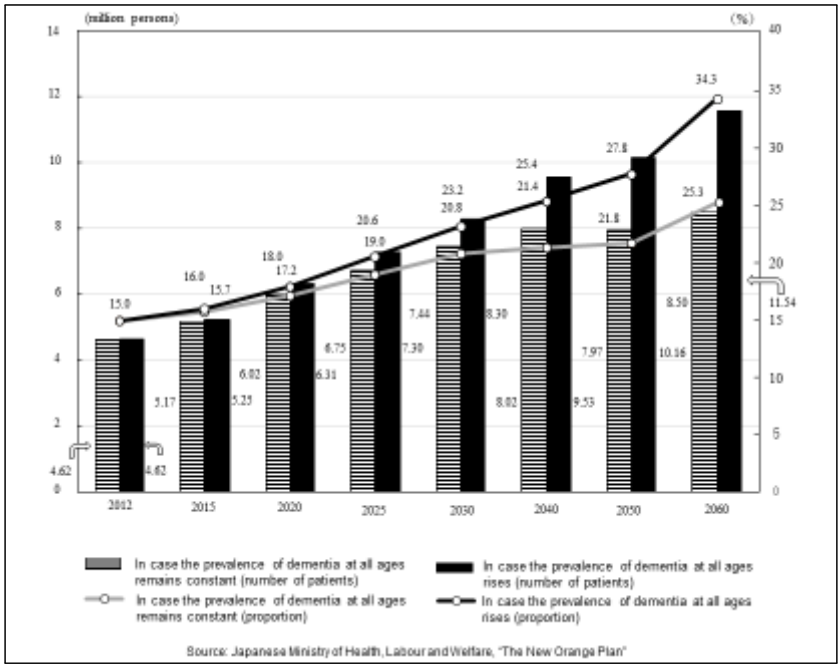
Hisayama in Fukuoka Prefecture. The proportion of survey subjects who underwent medical examinations was consistently high throughout the period covered by the survey: 95 percent (887 persons), 97 percent (1,189), 99 percent (1,437), 92 percent (1,556) and 94 percent (1,904), respectively. In almost all of the survey rounds, a two-stage method was applied. In the first stage, the subjects' cognitive functioning was evaluated using a neuro-psychological test, and those among them who were evaluated as being at risk of dementia were subjected to another test, in which based on their medical history as well as neurological and physical parameters, a diagnosis was made concerning the presence or absence of dementia, the severity and type of dementia.

Based on these data, a regression equation was estimated to compute the prevalence of dementia. In this regression, the dependent variable was whether or not the respondent suffers from dementia, while the explanatory variables were the respondent's age, sex, and whether he/she was facing the following risk factors: diabetes, high blood pressure, obesity, a past or present smoking habit. Then, by using these estimation results and the population projection prepared by the National Institute for Population and Social Security Research in 2012, the number of future dementia patients for entire Japan was projected. In addition, the following two projection cases were computed: Case I assumed that the estimated coefficients

would remain unchanged throughout the projected period, and Case II assumed that the prevalence of diabetes would increase by 20 percent between 2012 and 2060. These projected results are displayed in Figure 3. In Case I, the number of dementia sufferers aged 65 and over is as follows: 6.75 million (19 percent of those 65 and over) in 2025, 8.02 million (21.4 percent of those 65 and over) in 2040 and 8.5 million (25.3 percent of those 65 and over) in 2060. In Case II, the corresponding values are as follows: 7.30 million (20.6 percent of those 65 and over) in 2025, 9.53 million (25.4 percent of those 65 and over) in 2040 and 11.54 million (34.3 percent of those 65 and over) in 2060. Thus, the computational results generated by applying the Hisayama data to the population of entire Japan broken by age and sex suggest that the number of dementia patients in the country will increase to somewhere between 6.5 and 7 million in 2025, 8 and 9.5 million in 2040 and 8.5 to 11.5 million in 2060.

Furthermore, although this is not displayed in Figure 3, the number of Alzheimer's disease patients in 2025 is 4.66 million if we assume that the age-specific dementia prevalence rates remain unchanged throughout the period (Case I), or 5.04 million if we assume that there is an increase (Case II).

[Figure 3-3] Estimates of dementia sufferers over age of 65



Judging from our foregoing discussion, we may conclude that the estimations of dementia cases based on the Hisayama data offer useful information. Nonetheless, we would like to point out a few weaknesses in the estimation procedure. First, the estimated number of elderly dementia sufferers for the entire country is obtained by multiplying the age-sex-specific prevalence rates derived from microdata collected over the period of 27 years in a small rural administrative district (Hisayama town). That is, it is very unlikely that Hisayama's sample represents the entire country. At the very least, in addition to the (medical)

data obtained by the study carried out by Ninomiya, Kiyohara and Ohara (2014) under the auspices of the Ministry of Health, Labour and Welfare, data on education, income, assets and family composition in Hisayama town should have also been collected to examine whether their values are close to those for the entire Japan.

The second difficulty is that in the estimation of the number of elderly dementia patients, only two alternative projection cases involving the prevalence rates of dementia broken by age and sex obtained from Hisayama's inhabitants have been computed. As we have already discussed in the introductory section, a number of recent research findings from various countries, all of which have been referred to in the Lancet Commission report (Livingston et al., 2017), suggest that in many developed countries the onset of dementia is starting to happen at later ages. The studies also point out that one of the main factors behind this marked improvement is the rise in the educational levels among the elderly. As the Lancet Commission report suggests, if data on the subjects'educational attainment had been collected in the Hisayama cohort-based survey, a third projection case might have shown a considerably different trajectory.

Third, the extent to which the cognitive ability of Hisayama's residents was affected during the five rounds of the survey by macro-level economic changes and social transformations

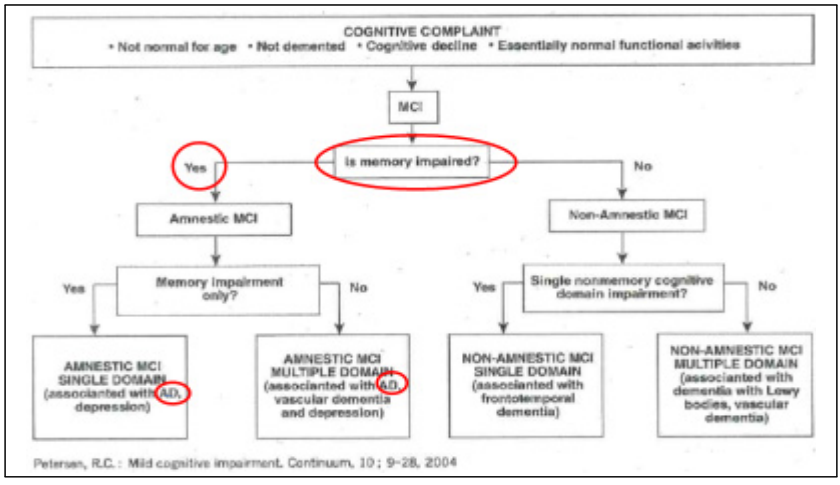
should have been analyzed, as has been done in various studies conducted in other industrialized nations (e.g., Van den Berg et al., 2010). As the National Transfer Account (NTA) project for Japan suggests, the wealth of many senior citizens has been affected to a significant extent by the Lehman shock of September 2008. For this reason, we may say that, it would have been very academically stimulating and useful, had the data obtained in the fourth and fifth round of the Dementia Survey in 2005 and 2012 yielded some insights regarding the impact of these economic difficulties. Also, we wish we were able to go further into the past and analyze the extent to which the "bubble economy", as well as the "burst of the bubble" and the "lost decade" (the period stretching from the second half of the 1980s to the second half of the 1990s), affected the cognitive ability of Japanese older adults.

Alzheimer's Disease and Cognitive Functioning among Old Adults

In their study report, Ninomiya and his associates (2014) revealed that there were 4 million patients with mild cognitive impairment (MCI) in Japan in 2012. Although this fact has not yet gained much attentionfrom mass media in Japan, it is an extremely important signal for Japanese society, so that we

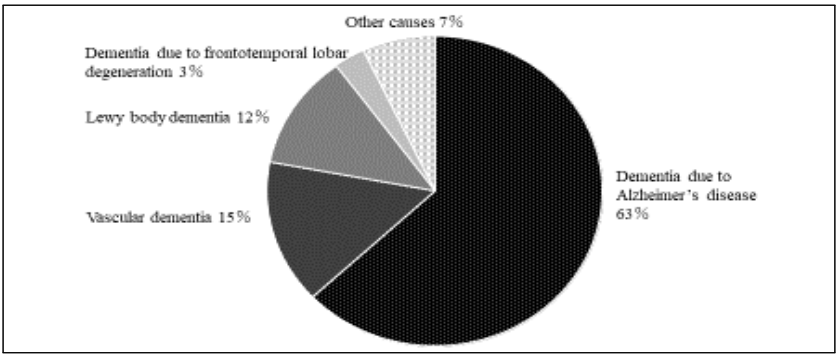
should not leave it unattended. As is widely known, a substantial proportion of persons with MCI are likely to develop Alzheimer's disease in due course. As depicted in Figure 4, whether or not persons with MCI have an impaired memory is a critical diagnostic point (Shimada et al., 2017). It has been widely accepted that an impaired memory can be detected on the basis of world recall measurements such as immediate and delayed word scores. More importantly, it has been shown by a number of previous studies (Shankle et al., 2005; Chaves and Camozzato, 2007; Takayama, 2010; Bastin and Salmon, 2014) that word recall measures are good cognitive markers of future Alzheimer's disease. If an individual with MCI has an impaired memory, he/she will need further diagnostic testing and treatment for Alzheimer's disease.

[Figure 3-4] Flowchart for Diagnosing Subtypes of Mild Cognitive Impairment



In the past 40 years or so, the composition of dementia cases has been changing drastically in Japan. In the early 1980s, roughly 60 percent of all dementia cases were of the vascular type, but the proportion of vascular dementia has continuously declined since the incidence of stroke started falling dramatically toward the end of the 20th century. As displayed in Figure 5, the proportion of vascular dementia cases fell to 15 percent in the recent past. In contrast, the proportion of patients with Alzheimer's disease among all dementia cases has increased from approximately 35 percent to 63 percent during the last four decades. Moreover, in the "New Orange Plan", it is projected to rise to 69 percent by 2025, as we remarked in footnote 9. In view of this rising trend of the share of dementia cases due to Alzheimer's disease, in the ensuing section we will analyze changing cognitive abilities of Japanese older adults.

[Figure 3-5] Proportion of dementia cases by type of underlying disorder in recent Japan



Source: Hisatomo Kowa, "Classificaton and Diagnosis of Dementia", *The Japanese Jounmal of Rehabilitation, Medicine*, Vol. 55, 2018, p. 638.

An Assessment of Cognitive Functioning among the Elderly in Japan

In the remaining part of the present paper, by heavily drawing upon JSTAR (Japanese Study of Aging and Retirement) data, we analyze how and to what extent the cognitive abilities of older Japanese adults vary with demographic, socioeconomic, and biomedical factors. Then, based upon the computed results, we compare the current level of their cognitive capacity with that for other countries in Asia and in the West. Moreover, we discuss the likely future trend in the cognitive functioning of Japanese older adults, and evaluate the validity of the long-term projection of dementia patients which has been used as one of the key inputs for formulating the "New Orange Plan".

1. Earlier studies on cognitive functioning

Before estimating a few regression equations, let us briefly discuss some of the previous studies which provide a theoretical base for specifying a key equation.

Higher chronological age tends to be related to a host of health risks such as cardiac infarction and cerebral hemorrhage (Slomski, 2014). Similarly, cognitive functioning tends to be a good predictor of future morbidity and mortality (Negashi et al., 2011). Therefore, individuals with higher cognitive abil-

ities are more likely to be healthier and live longer than those with lower cognitive abilities. It is worth noting that, as demonstrated by numerous studies (e.g., Skirbekk, Loichinger, and Weber, 2012), cognitive abilities predict individual productivity better than any other observable individual characteristic and that they are becoming increasingly relevant for workers' performance in the labor market. More importantly, this finding is applicable to many countries, both developed and developing, and different settings, both urban and rural (Behrman, Ross, and Sabot, 2008).

Over the past few decades, the number of seniors has been increasing in labor markets at an accelerating pace. In this regard, it should be noted that because certain cognitive abilities decline substantially at late adult ages, most of the past studies conducted with regard to older workers have focused on the population aged 50 and older (Anderson and Craik, 2000; Coe and Zamarro, 2011; Bianchini and Borella, 2016; Mazzonna and Peracchi, 2017). The potential lifetime length of staying in the labor market is determined by how long individuals can retain high cognitive performance.

Weir, Lay, and Langa (2014) have analyzed data from the HRS-like studies for China (China Health and Retirement Survey, "CHARLS" for short) and India (Longitudinal Aging Study in India, "LASI" for short), as well as from the WHO Study of Global Aging and Adult Health (SAGE), to examine the pattern of gen-

der inequality in cognition. They have found that despite some notable differences in samples and measures, a strong general association of cognition in older ages with education emerges as a potential explanation for gender gaps and cohort differences. They have also found that female disadvantage in cognition is greater in both China and India, before and even after controlling for education.

Doblhammer, van den Berg, and Fritze (2013) have examined, by utilizing data gleaned from the Survey of Health, Ageing and Retirement in Europe (SHARE), cognitive functioning at age 60 and over. In their study, a total of 17,070 persons in ten SHARE member countries were included in the analysis of several domains of cognitive functioning, which was linked to the macroeconomic deviations in the year of birth. One of the main findings of this study was that economic conditions at birth significantly influence cognitive functioning late in life in various domains. Another finding was that economic recessions adversely affected numeracy, verbal fluency, recall abilities, as well as the score on the omnibus cognitive indictors.

Skirbekk, Loichinger, and Weber (2012) have examined the intercountry age variation in cognitive functioning, measured in terms of immediate recall score. They have computed the mean age-group-specific immediate recall score for 20 countries, using data from the HRS, SAGE, SHARE Northern Europe, SHARE Continental Europe, and SHARE Southern Europe. Caution

should be exercised, however, in interpreting their computed results. The mean value of the immediate recall score was computed for 5-year age groups in each survey, but there are some differences between the surveys in the way in which the respondents are tested. That is, while the respondents in the United Kingdom and the United States were given two minutes, the respondents in the other 18 countries had only one minute for recall. Furthermore, while in SAGE the interviewers read out ten words that needed to be memorized three times, in the rest of the surveys, the words were read out only once. Despite these differences in the way of collecting data on the immediate word recall, the computed results showed a statistically significant age-related decline in all countries within the 50-84 age interval.

2. Immediate recall scores: Japan vs. selected countries

Following the steps taken by Skirbekk, Loichinger, and Weber (2012), to compute the mean age-group-specific immediate recall scores for various countries, we will calculate, by drawing on micro-level data from JSTAR, the mean age-group-specific immediate recall score for Japanese older adults, and then compare the computed result for Japan with that for some countries selected from the list of countries in the study done by Skirbekk, Loichinger, and Weber (2012).

JSTAR is a longitudinal, inter-disciplinary survey that collects internationally-comparable data on the middle-aged and old. The JSTAR project commenced in 2007 and the survey has been implemented in two-year intervals. JSTAR is a sister survey compatible with the HRS, ELSA, SHARE, CHARLS, and LASI. 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 to 79 from ten municipalities. The respondents were randomly chosen from household registries in each of the ten cities, towns or villages. The sample size and the average response rate at the baseline are approximately 8,000 and 60 percent, respectively. JSTAR collects a wide range of variables including the economic, social, familial and health conditions of the sampled respondents.

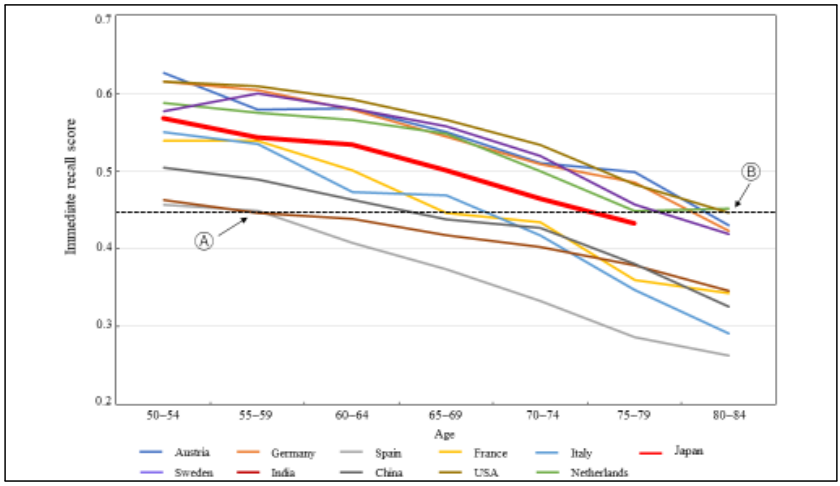
With a view to avoiding problems arising from non-random dropout and retest-practice effects associated with longitudinal surveys (Thorvaldsson, Hofer, Berg, and Johansson, 2006; Skirbekk, Bordone, and Weber, 2014), we have utilized only the data from the first round of JSTAR coming from the following 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). As is the case with most of the internationally-comparable surveys such

as SHARE, JSTAR respondents listened to ten words read out by the interviewers, and were given one minute to recall them.

Figure 6 compares Japan's mean age-group-specific immediate recall score from 2007-2011 with those for the sevenSHARE countries in 2006/2007 (Austria, Germany, Spain, France, Italy, the Netherlands and Sweden), the United States from the 2006/2007 HRS, and the two Asian countries (China and India) from the 2007/2009 SAGE. A quick glance at this graphical expositionreveals a few interesting patterns of change among these 11 countries. Regarding age group 50-54, Austria has the highest score (0.626 = 6.26 words recalled out of the 10 words read out), followed by Germany (0.615) and the United States (0.614), and these three countries also show a comparable age-specific pattern of change. Also, immediate recall age trajectories for Japan, the Netherlands, and Sweden are comparable. Furthermore, relative to the other selected European countries, France and Italy have considerably lower scores. A more extreme case is Spain - its scores are consistently the lowest at all age groups among the 11 countries listed in Figure 6. It is also interesting to observe that, compared with others, India has a distinctively flatter age-cognition curve. Regarding the age group 50-54, China has a higher score than India, but at the age group 80-84, China is overtaken by India. This may reflect a selectivity mechanism in operation in India - it is conceivable that the cohorts presently 50 years of age and older in India

grew up during a period of widespread poverty and high mortality, and that, as a result, the population is positively selected in terms of cognitive performance at a more advanced age (Skirbekk, Loichinger, and Weber, 2010).

[Figure 3-6] Mean age-group-specific immediate recall scores in 10 selected countries and Japan circa 2010



Source: See the main text.

In Figure 6, we have optionally drawn a dotted line at the score 0.45 for facilitating an interesting discussion. The point Ⓐ denotes the average Spanish person at age 57.5, and point Ⓑ corresponds to the average American person at age 82.5. From this we can see that, at present, the average Spanish person at age 57.5 and the average American person at age 82.5 have the same level of cognitive functioning. This implies that there is a

huge difference between the two countries in cognitive functioning, which will likely be a crucial factor in intercountry transfers of new technologies and innovative production methods in the future.

The foregoing comparative analysis seems to indicate that Japan's recent pattern of a statistically significant age-related decline in cognitive functioning is highly comparable to that of many developed nations in Europe. Furthermore, virtually at all age groups, Japan's mean values of age-specific immediate recall score are fairly close to that for Northern European countries.

3. Measuring the effect of changing age-specific cognitive abilities on the age composition

At this point, let us link the computed mean age-group-specific immediate recall score to the context of population aging. To do that, we draw upon a new indicator that focuses on cognition and demographic change: cognition-adjusted dependency ratio (CADR), which was proposed by Skirbekk, Loichinger, and Weber (2012).

The formula for CADR is expressed as follows:

$$CADR = \frac{|\{x \in P | (m_x < 0.5) \wedge (age_x \geq 50)\}|}{|\{x \in P | (15 \leq age_x < 50\} \cup \{(m_x \geq 0.5) \wedge (age_x \geq 50)\}|'}$$

where mx represents the memory score of person x, agexre-

presents the age of person x, while P stands for population. To compute the CADR, we have applied the mean age-group-specific immediate recall scores for Japan and other countries listed in Figure 6 to the relevant age compositional data derived from the United Nations population projection. The calculated results are indicated in Table 1. Although Japan's CADR value (0.18) is higher than the corresponding values for the United States and Northern Europe (encompassing Denmark, United Kingdom, Ireland, and Sweden), Japan's dependency ratio adjusted by age-specific cognitive scores is highly comparable to that of Western Europe (Austria, Belgium, France, Germany, the Netherlands, Poland, and Switzerland), and is considerably lower than that of Southern Europe (Greece, Italy, and Spain).

〈Table 3-1〉 International comparison of the CADR score

• USA	0.10
• Northem Europe (Denmark, UK, Ireland, Sweden)	0.12
• Western Europe (Austria, Belgium, France, Germany, the Netherlands, Poland, Switzerland)	0.18
• southern Europe (Greece, Italy, Spain)	0.32
• Asia	
India	0.14
China	0.15
Japan	0.18

The intercountry comparative analysis based on Figure 6 and Table 1 seems to indicate that Japan's recent level of cognitive functioning among those aged 50 and over is clearly comparable to that of many developed nations in Europe, partic-

ularly in the western part of it. Furthermore, virtually in all age groups, Japan's mean values of age-specific immediate recall score are fairly close to those of Northern European countries. More importantly, these comparative results based upon the cognition-adjusted dependency ratio are astonishingly different from the results emerging from Table 2, which reports the conventional old-age dependency ratios for the countries listed in it. This finding seems to justify the United Nations' recent efforts to raise awareness regarding the urgent need for remeasuring population aging with a view to formulating effective policies for coping with it in both developed and developing nations.

〈Table 3-2〉 Intercountry comparison of age compositional indices

Region/country	Year	Total dependency ratio	Aged dependency ratio
Northern America			
United States	2000	49.6	19.4
Northern Europe			
Denmark	2000	52.9	25.5
United Kingdom	2000	51.8	25.2
Ireland	2000	46.8	16.4
Sweden	2000	53.2	27.9
Western Europe			
Austria	2000	48.2	26.4
Belgium	2000	52.0	26.4
France	2000	54.4	26.0
Germany	2000	51.8	31.2
Netherlands	2000	49.2	23.0
Poland	2000	40.2	18.9
Switzerland	2000	47.0	24.9
Southern Europe			
Greece	2000	49.9	27.5
Italy	2000	52.7	31.3
Spain	2000	46.7	25.2
Asia			
India	2000	56.3	8.0
China	2000	35.6	11.4
Japan	2000	55.9	35.1
Japan	2015	64.9	42.7

Source: United Nations, 2017, *World Population Prospects*, the 2017 Revision.

4. Determinants of cognitive performance

In this subsection, we will identify, by running a linear regression, the determinants of immediate recall scores among the Japanese adults aged 50 and over included in the first wave of JSTAR in the ten municipalities. The total number of observations amounts to 6,412. The dependent variable is the number of words recalled by the respondent immediately after ten words have been read out. In this regression, we have introduced the following ten explanatory variables: age groups (50-54, 55-59, 60-64†, 65-69, 70-74, and 75-79), sex (men, women†), marital status (currently married, currently not married†), work status (working, not working†), education (junior high school†, senior high school, junior college, university or higher), self-rated health status (excellent, very good, good, fair†, poor), CES-D (≧16, 〈16†), IADLs(≧1, 0†), height (cm), and municipalities (Takikawa, Sendai, Adachi, Chofu, Kanazawa, Shirakawa, Tondabayashi, Hiroshima†, Tosu, Naha). Except for the respondents' height, all other explanatory variables are dummy variables with the dagger notation (†) representing the reference group.

The respondent's age and education have been incorporated in this regression in order 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 that are acquired throughout life (Cattell, 1978). The explanatory variable, age, is expected to capture the change in fluid intelligence which peaks out approximately at age 25. Because the respondents included in the regression are older than 50, the estimated coefficients are expected to have negative signs. The other explanatory variable isintended 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. Thus, 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 for the other variables, the health-related explanatory variables such as the self-rated health status, CES-D (the Center for Epidemiologic Studies Depression Scale), and IADLs (instrumental activities of daily living) are expected to contribute to a higher cognitive performance. The respondent without a spouse is likely to be left alonewithout having anybody to communicate with, which should weaken his or her cognitive functioning. Similarly, whether or not the respondent holds a job is likely to affect his/her level of crystallized intelligence.

The respondent's height has been incorporated in the regression due to the fact that adult height is closely related to childhood nutritional condition, which in turn, affects cogni-

tive functioning and other dimensions of human capital, such as school ability (LaFave and Thomas, 2017; Weir, Lay, and Langa, 2014). Moreover, the same empirical studies show that women tend to perform better in terms of immediate recall than their male counterparts.

We have also included in the regression a set of explanatory variables representing survey areas, which differ significantly in terms of the level of urbanization and lifestyles. It is quite conceivable that a large proportion of older persons living in Chofu, which is a relatively wealthy urban area in Tokyo, are exposed in their daily lives to modern technologies such as the internet and computers. It is plausible that those who often use these modern technologies, by doing so, stimulate their crystallized intelligence (Bordone, Scherbov, and Steiber, 2015).

Table 3 shows the estimated results. All the explanatory variables except for the respondent's work status are statistically significant, with the coefficients having expected signs. One of the key findings is that education has a huge impact on immediate recall scores; the higher the educational level, the better the cognitive performance. Another important finding is that the respondent's health conditions (both physical and mental) relate positively with the immediate word recall. Moreover, women show a considerably higher cognitive score than men, which is comparable to the pattern widely prevailing in developed countries. It should be noted, however, that this JSTAR-

based result pertaining to the gender cognitive gaps is contrary to the pattern being observed in other Asian countries such as India and China, as previously mentioned (Weir, Lay, and Langa, 2014). It is interesting to observe that the respondent's height is positively linked to better cognitive ability, which implies that the nutritional condition in childhood plays an important role in developing cognitive functioning. It is also worth observing that the coefficient for Chofu is not only statistically significant but also positive, which is in agreement with our a priori expectation.

〈Table 3-3〉 Regression Analysis of Immediate Recall Soore
(Dependent variable - Immediate recall score)

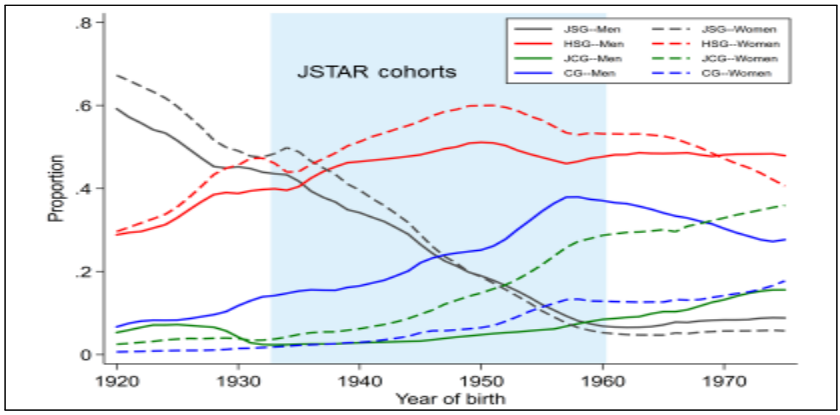
Explanatory variables	Coefficient	T-value	
Age			
50-54	0.215	3.12	**
55-59	0.046	0.75	
60-64 †	-	-	
65-69	-0.244	-3.93	***
70-74	-0.477	-7.34	***
75-79	-0.776	-5.49	***
Sex			
Man	-0.569	-8.91	***
Woman †	-	-	
Marital status			
Currently married	0.106	1.85	*
Currently not married	-	-	
Work status			
Working	-0.007	-0.16	
Not working	-	-	
Education			
Junior high †	-	-	
Senior high	0.384	7.22	***
Junior college	0.491	6.95	***
University or higher	0.686	9.39	***

† denotes the reference group.
Adjusted R-squared = 0.136 *Number of observations = 6,421*
*Level of statistical significance: * 10% level; ** 5% level; *** 1% level*

Explanatory variables	Coefficient	T-value	
Self-rated health status			
Excellent	0.217	3.15	***
Very good	0.171	2.57	**
Good	0.151	2.39	**
Fair †	-	-	
Poor	-0.356	-2.75	***
CES-D			
≧16	-0.102	1.80	*
<16 †	-	-	
IADLs			
≧1	-0.187	-4.45	***
0 †	-	-	
Height	0.007	1.81	*
Municipalities			
Takikawa	-0.705	-7.56	***
Sendai	-0.072	-0.87	
Adachi	0.000	0.00	
Chofu	0.291	2.61	***
Kanazawa	-0.136	-1.68	*
Shirakawa	-0.167	-1.89	*
Tondabayashi	-0.197	-1.84	**
Hiroshima †	-	-	
Tosu	-0.289	-3.13	**
Naha	-0.348	-3.97	***
Intercept	4.194	7.16	***

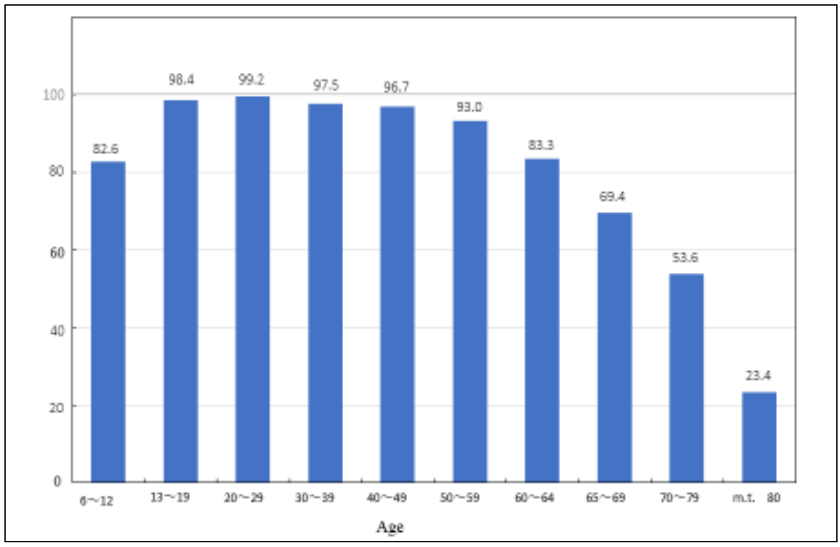
These statistical results indicate that the cognitive ability of Japanese older adults is likely to improve in the years to come due to the following: (1) the level of education among those 50 and over is expected to rise at a phenomenal rate, as shown in Figure 7, (2) the nutritional condition of Japanese seniors is likely to improve in the years ahead due to the fact that children's diet began to improve considerably since the late 1950s, when the school lunch program started on a nation-wide basis, (3) the use of modern communication technologies among the elderly is likely to grow at a remarkable rate because the young cohorts' exposure to computers and mobile phones is large, as illustrated in Figure 8. In addition, judging from the long-term trends of life expectancy at age 50 in Japan, it seems safe top-resume that the physical conditions of the Japanese elderly will continuously improve in the years ahead.

[Figure 3-7] Changes in the educational composition, by sex (1920-1980)



Source: statistics Bureau, various years, *population Census*.

[Figure 3-8] Age-specific pattern of using the Internet, 2016



Source: Ministry of Internal affairs and Communications, 2017, *Communications Usage Trend Survey*.

Concluding Remarks

According to the long-term projection of the number of patients with dementia in Japan, conducted by Ninomiya, Kiyohara and Ohara, the proportion of those with dementia in the population 65 and over is expected to increase from 16 percent in 2015 to 20.8 percent in 2030. More importantly, it should be noted that this increase is likely to accelerate in the 2020s, particularly after the postwar baby boomers exceed the age of 75 in the early 2020s. These future prospects have been fully reflected in the "New Orange Plan".

Caution should be exercised, however, in accepting these projected results. The main data base used for computing the long-term projection was formed relying on micro-level data gleaned from a few rounds of the above-mentioned cohort survey undertaken in a small rural town. Hence, the validity of these projected numbers needs to be continuously assessed as more dependable data, preferably gathered on a national scale, become available with time.

In addition, our JSTAR-based analysis suggests that because it is almost certain that Japan's educational and nutritional levels will continue to rise in the years ahead, the cognitive abilities of Japanese persons aged 50 and over are very likely to improve, thus delaying the age of the onset of Alzheimer's disease - a pattern that has recently been emerging in a number of developed countries in North America and Europe.

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IV

Population Ageing and Economic Activity by Age in the EU Countries

IV Population Ageing and Economic Activity by Age in the EU Countries

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Abstract

European countries are very heterogeneous, but they all face rapid population ageing that will continue in the next few decades. Age is one of the key determinants of people's economic behaviour. Therefore, changes in the population age structure have numerous economic consequences that bring challenges to the public institutions. In the European research project called "AGENTA" we applied in a totally synchronized manner the National Transfer Accounts (NTA) methodology to decompose economic activities, such as income, consumption, transfers and savings, by age. Namely, the economic consequences of population ageing depend not only on the degree of ageing but also on the age patterns of economic activity. Our results show that countries like Greece and Romania where labour income falls short of consumption already at age 54 would greatly improve the public transfer system sustainability

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by following Swedish example where this happens ten years later. Moreover, a high consumption at older ages is less problematic when substantially financed through savings (like in, for example, the UK) rather than almost exclusively through public transfers (like in, for example, Estonia and Austria). The fully comparable cross-country analysis of the intergenerational transfer systems for 25 EU countries allows us to identify strategies that could be successful in reducing the pressure of population ageing on the funding of public transfers. These strategies generally include: 1) reducing the economic dependency of the elderlypopulation and 2) increasing the capacity of the working-age population to support others. Among the most efficient strategies which addresses both of those dimensions is an increase in the labour force participation of elderly people.

Introduction

In the coming decades, the Europe as the "Old continent" will get even much older. According to the latest Eurostat's projections EUROPOP2018 in EU 28 countries the share of people aged 65 years and over will increase from 19.7% in 2018 to 28.5% already by 2050 and to 29.1 by 2060 (Eurostat, 2019). In the same period the share of working age population is projected to decline from 59.4% to 52.1% in 2050 and 51.6% by

2060. A rapid population ageing is happening in the European countries for quite some time already. Around the year 2000 the population started to generate "negative momentum"with a tendency to decline due to the shrinking cohorts that were born in the previous three decades (Lutz, O'Neill, & Scherbov, 2003). Nevertheless, according to the Eurostat 2018 projections the population of EU 28 will still be increasing in the next quarter of the century from 512 million in 2018 to 525 million in 2044 due to rapidly increasing longevity and positive net migration.

The rapid population ageing raises worries about long term sustainability of the public system. In 1990s researchers warned that it is not enough to monitor how sound the public finances are only by the public debt and budget deficit. The method called Generational accounting (GA) has been introduced to identify the size of the intertemporal imbalances of the public sector (Auerbach, Gokhale, & Kotlikoff, 1991,1994). All inflows and outflows of the public sector have been allocated by age and applied on the population projections. The future inflows and outflows were projected and discounted back to the base year. It turned out that in many countries those implicit liabilities were much bigger than the official public debt. The GA calculations have been conducted on many countries worldwide (for example, Auerbach & Chun, 2003; Auerbach, Kotlikoff, & Leibfritz, 1999; European Commission, 2000). Researchers were

trying to make their results comparable by using the same approach and the same assumptions on growth and discount rate.

A similar development took also the European Union in monitoring the public system stability in country members – first focusing on public debt and budget deficit and later also on long term expenditure projections. With the Maastricht Treaty signed in 1992 the further integration of the European countries and the single European currency (Euro) was foreseen. Two of the obligations for thecountry members to keep sound fiscal policies were set: the public debt should be limited to 60% of GDP and the annual budget deficit should not be greater than 3% of GDP. In 1997 the Stability and Growth Pact (SGP) was formalized as a set of fiscal rulesdesigned to prevent countries in the European Union from spending beyond their means. In 2005 the SGP was updated to the current form of the Medium-Term Budget Objective (MTOs) for the annual assessment of the sustainability of public finances. Every three years the Economic and Financial Affairs (ECOFIN) Council mandates the Economic Policy Committee (EPC) to prepare the age related expenditure projections. The EPC further mandates and collaborates with the Ageing working group (AWG) to carry out the necessary input for calculations. Majority of the AWG consists of two national expert representatives from each country member and there are many more experts in the national AWG teams for providing the data, simulations and information on

the national systems. Based on the AWG work the Directorate General for Economic and Financial Affairs (DG ECFIN) provides the necessary analysis and calculations used in the Ageing reports. The demographic projections are carried out by Eurostat (European Commission, 2018).

The projections for the later four categories are prepared centrally, whereas the pension projections are carried out by the member states using their own national models and undergo a peer reviewed process carried out by the AWG. This way the national models can incorporate the country specific circumstances and the impact of foreseen changes that are already in the pension legislation. At the same time the commonly agreed macroeconomic underlying assumptions on labour force (employment and unemployment rates), labour productivity and the real interest rates must be used (European Commission, 2018) to make the results comparable across countries.

The latest "Ageing report 2018" includes the projections of ageing related expenditures for the period up to 2070. The projections have more than just an informative nature. Based on those results the Medium Term Budget objectives (MTO's) are calculated that have to be taken into account by country members in planning their national fiscal budgets. In the case a country member would deviate too much from the agreed rules, the sanctions are foreseen.

We think that rules and commitments to act is an important arrangement for acting timely to population ageing. Otherwise, politicians and policy makers tend to have short horizon of planning –often till the next elections only. The described mechanism of cross country comparable results and commitments to act pushes national governments to introduce necessary measures. Also, it gives them a good arguments for negotiations with the unions, other social partners and general public in the country.

The allocation of expenditures by age is a crucial component in both the above mentioned generational accounting approach and in projecting ageing related expenditures. However, not only public expenditures and revenues have a strong age ingredient and therefore being affected by the population ageing. In this paper we build on the National Transfer Accounts methodology that allocates by age all economic flows in a country including private transfers and even services produced and consumed in form of an unpaid household work. We think that cross country comparison of the NTA results provides important insights in country characteristics and the potential future challenges coming from population ageing. They can be very valuable for policy makers and supplement the above-mentioned analysis that is focused on public sector only.

We start this paper by presenting the National Transfer Accounts methodological framework that is extendedalso on

the unpaid household work. Next, we show a cross-country comparison of economic activity and consumption by age – which are the main elements of the NTA. Then, we present how much of the total labour income is needed to finance the difference between consumption and labour income of the elderly but also whether it is covered through transfers or through net asset income. The more the system relies on transfers relative to net asset income, the more it is vulnerable to the population ageing – which is the case in European countries. Furthermore, we present the increased labour market participation rates as a measure for promoting public sector sustainability. This can be done by entering the labour market earlier, withdrawing later or by increasing the work in prime age including the increase in employment of women in countries where it strongly lags behind the employment of men. Finally, we provide projections of dependency ratios taking into account population projections and the distribution of work and consumption across age. Taking into account the actual distribution of production and consumption across age provides better projections of dependency in the future than arbitrarily set age thresholds of dependent and productive age. In the last section we discuss the results and summarize policy implications of the paper.

Age decomposition of economic activities

In our analysis we use fully comparable results of National Transfers Accounts (NTA) for 25 EU countries in 2010 that are extended by gender dimension and, when data available, monetary values of unpaid household work. Namely, the age of producers and consumers of unpaid household work differ considerably and therefore there could be potential future imbalances between consumption and production because of population aging as well. The value of unpaid household work is calculated based on time use surveys and therefore National Time Transfer Accounts (NTTA) has been introduced. Based on the combined NTA and NTTA data, we make a cross-country comparison of the effect of population ageing on the sustainability of the public finance systems. Additionally, we propose possible strategies that could at least partially mitigate the effect of population ageing.

Age is one of the main determinants of individuals' economic behaviour. Therefore, change in the population structure will bring numerous economic consequences that bring challenges but also opportunities for both private and public institutions. The aggregate economic data, such as the System of National Accounts (SNA) data, includes very limited information about age specific economic categories, which restrains our understanding of the economic consequences of population ageing

and our understanding of the cooperation between private and public institutions in providing well-being of the youth and the elderly (United Nations, 2013).

During our lives, we face two periods of economic dependency: when we are young and when we are old. During these two life stages our consumption exceeds our labour income. To fund the excess of consumption over the labour income, dependent individuals rely on the working age population, whose labour income exceeds consumption and therefore faces a period of economic independence. This gap between consumption and labour income is possible only because different institutions, such as family, government, and market, play the role of intermediaries between individuals and time periods. These institutions enable the reallocation of resources across different age groups. For example: 1) family transfers are vital for the young, especially transfers from the parents to their children. 2) Government collects taxes and social contributions from those of working age and uses the money to support the young and the elderly through publicly funded education, health care, long-term care, pensions, etc. 3) Capital and financial markets enable individuals to accumulate assets at one moment in life and spend these assets later in life (Lee & Mason, 2011).

In the last few decades there was a great progress in the estimation of intergenerational transfers on both micro and macro levels (Mason, et al., 2006). As mentioned before, there was a

big step made by the generational accounting approach (e.g., Auerbach, Gokhale, & Kotlikoff, 1994; Kotlikoff & Summers, 1981; Leibfritz, Kotlikoff, & Auerbach, 1999). However, the GA focus only on economic flowsthrough the public system. But to comprehensively understand the effect of population ageing on intergenerational transfer systems, private transfers should be accounted as well. Recently, several researchers have recognised the importance of private transfers in the welfare provision for the dependent population (e.g., Albertini & Kohli, 2013; Albertini, Kohli, & Vogel, 2007; Attias-Donfut, Ogg, & Wolff, 2005), but they mainly focused on private intergenerational transfers. Only some of them connected public and private transfer systems (e.g. Brandt & Deindl, 2013, Mudrazija, 2016), but they focused only on specific age groups. However, to fully understand societies' arrangements of intergenerational reallocation of resources, flows among all age groups should be considered.

The National Transfer Accounts (NTA) were developed to better understand the economic consequences of population ageing and to provide a systematic and comprehensive analysis of intergenerational reallocations in form of private and public transfers and private and public asset based reallocations that result from interactions with capital and financial markets. The NTA introduces age dimension into the SNA and as such helps us to better understand how individuals in different societies

arrange their production, consumption, and reallocation of resources over their lifetimes.

In the past, ten EU NTA research teams estimated full NTA accounts for their countries, but for different reference years and using different data sources, which to some extent limits the comparability of existing NTA results. This paper includes publicly available NTA results for 25 EU countries (all the EU member states except Croatia, the Netherlands, and Malta) that were estimated as part of AGENTA project. The results were estimated for only 25 EU countries due to unavailability of survey or macroeconomic data. The accounts are estimated in as comparably as possible way by using the same micro- and macro-level data sources for the same reference year, 2010. Furthermore, to analyse the economic consequences of population ageing and possible solutions that would decrease the burden of population ageing on the sustainability of the public finance system in EU countries, we combine standard NTA estimates with those disaggregated by gender. The gender-specific NTA results are further combined with the results of National Time Transfer Accounts (NTTA) that are monetized values of unpaid household work.

National (Time) Transfer Accounts data

1. National Transfer Accounts (NTA)

The NTA methodology is presented in the book Population Ageing and Generational Economy, edited by Lee and Mason (2011), which also includes results for 23 countries around the world. The technical details of the NTA methodology are described in the National Transfer Accounts Manual (United Nations, 2013). The specifics of the European NTA are presented in the European NTA Manual (Isteniè et al., 2017).

The NTA methodological framework is based on an individual's budget constraint, where all the inflows (i.e. labour income, asset income, and transfer inflows) should match the outflows (i.e. consumption, savings and transfer outflows). By rearranging these terms, we get the NTA flow identity equation. The flow identity equation consists of the 'life cycle deficit'(LCD), which shows the difference between consumption and labour income. The LCD equals the sum of net transfers (defined as the difference between transfer inflows and transfer outflows) and asset based reallocations (defined as the difference between asset income and savings). The LCD is positive for the young and the elderly and negative at working-ages. All the flows, compounding the flow identity, are further disaggregated into more detailed components and, whenever applicable, dis-

aggregated by sectors (i.e. into the public or private sector). The flow identity holds for each individual, for each age groups and for the economy as whole.

Analysing economic life cycle and the channels through which economic life cycle is financed requires to estimate da large set of age profiles. The age profiles are the age-specific weighted averages of the economic categories compounding the flow identity. To calculate age profiles, we first need to derive the macroeconomic aggregates, based on the European System of Accounts (ESA) and other related sources. In the second step, we calculate the age distribution of different economic categories, using survey and/or administrative data. The main survey data sources for constructing European NTA results are EU Statistics on Income and Living Conditions (EU-SILC) – for constructing income-related variables –and the Household Budget Survey (HBS) for constructing private consumption age profiles. Both surveys include harmonized data for European countries. Administrative data is mainly used to calculate the flows that are mediated by the public sector. In the final steps, the majority of the age profiles are smoothed using Friedman's SuperSmoother (Luedicke, 2015) and adjusted to match the macroeconomic aggregates.

1) Labour income, consumption, and economic life cycle

The labour income age profile includes gross earnings of employees (including employer's social contributions) and self-employment labour income. The macroeconomic aggregate for earnings can be directly estimated using ESA, while the aggregate value of the self-employment labour income contains two-thirds of gross mixed income (the rest is attributed to the capital income). The age profiles for labour income are estimated using EU-SILC survey data that includes information on wages, salaries, employers' social contributions, and self-employment income on the individual level.

The consumption as defined in the NTA includes private and public consumption. Both, private and public consumption are further disaggregated into education, health, and other private or public consumption. The private consumption age profiles are mainly based on the HBS 2010 survey data, where expenditures are collected only at the household level. To allocate expenditures reported at the household level among the household members, we need to use different allocation rules. To allocate household expenditures on education among the household members, data on level specific household expenditures are combined with the educational enrolment data of the household members. To estimate age-specific private consumption on education, we assume that the unit costs are

equal for all household members enrolled at a specific level of education, independently of their age.

The age profile of private health consumption is estimated using a regression function without a constant term, where we regress household health expenditures on the number of household members of a specific ten-year age group. The regression coefficients are then used as weights to allocate total household expenditures for health among the individual members.

The private consumption other than education and health is allocated using the modified Deaton's (1997) equivalence scale. We assume that individuals aged 20+ have the same consumption share, equal to 1. For children below the age of 4, we assume that they consume 0.4 of the consumption of an adult. For children between ages 4 and 20, we assume a consumption share that increases linearly from 0.4 to 1.0 of the consumption of an adult aged 20+.

Next, to estimate the public consumption age profiles, we use administrative data, government reports, etc. We distribute government consumption among those individuals who are assumed to be beneficiaries of a specific public programme. The age profile of public education consumption is estimated by first dividing total public education expenditures among different levels of education. Next, we combine data on level-specific expenditures with the data on age- and level-specific enrolment rates. We again assume that the unit cost of education is

equal for all students enrolled at a specific level, independently of their age.

Because there is no administrative data source with comparable data on public health expenditures forall EU countries, the age profiles of public health consumption are calculated based on the pre-calculated age profiles of health care consumption received from the Ageing Working Group (AWG). The age profiles are generally estimated by using the AWG report from 2012 (European Commission, 2012) and are further adjusted to match the country specific macroeconomic aggregate for 2010.

Other public consumption consists individual and collective consumption. Public collective consumption includes consumption ofpublic goods, such as public defence, street lighting, etc., and is allocated equally among all individuals, regardless of their age. On the other hand, individual public consumption is distributed age-specifically. For example: 1) the 'old age' and 'sickness and disability'benefits are assumed to have the same distribution as publicly financed long-term care (also based on AWG data). 2) We assume that 'unemployment', 'family and children', and 'housing' benefits are distributed in the same way as the corresponding public transfer inflows in cash, further explained below.

2) Public reallocations

Public reallocations consist of net public transfers and public asset-based reallocations, where net public transfers present the difference between public transfer inflows and public transfer outflows. Public transfer inflows include in-kind and in-cash public transfers received by individuals. Public transfer inflows in kind equal public consumption explained above, whereas public transfer inflows in cash aremonetary transfers such as public pensions, unemployment benefits, family benefits, etc. Public transfers in cash are direct payments to individuals and thus reported in the EU-SILC survey data mainly at the individual level.

Public transfer outflows mainly consist of taxes and social contributions paid by the private sector (individuals or firms) to the government. We distinguish among taxes on asset income, taxes on labour income, taxes on consumption, social contributions paid by non-employed and social contributions paid by employers and employees. The age profiles of public transfer outflows are based on the pre-calculated NTA age profiles. For example, the age profile of taxes on labour income and the age profile of social contributions paid by employers and employees are based on the labour income age profile.

However, taxes and social contributions may not be enough to cover public transfer inflows. In such case public transfer

deficit is generated. The government covers the public transfer deficit through positive asset-based reallocations (ABR), for example by issuing public debt. Public ABR therefore equal the public transfer deficit or public transfer surplus (if vice versa happens and public transfer outflows exceed inflows). Furthermore, public ABR represent the difference between public asset income and public savings. Because public sector does not accumulate profits, public asset income mainly consists of public property income, such as interest paid or received on public borrowing or landing, currency stabilization funds and sovereign wealth funds (e.g. oil revenue). The age profile of public asset-based reallocations is based on the age profile of public transfer outflows.

3) Private reallocations

Private reallocations consist of net private transfers and private ABR. Private ABR equal asset income less savings. Asset income includes capital and property income. The age profiles of capital and property income are based on the EU SILC survey data. As asset income is reported only at the household level in the EU-SILC, we assume that all the asset income is received by the household head. Private savings are estimated as a residual component of the individual's flow identity.

Private transfers include inter-household transfers (transfers

between households) and intra-household transfers (transfers within households). Inter-household private transfers are direct transfers between households, such as alimony payments, gifts, etc. These transfers are reported in the EU-SILC survey data, however, at the household level only. Therefore, as in the case of asset income, we assume that all the inter-household transfer inflows/outflows flow to/from the household head.

Even though the intra-household transfers equal zero at the aggregate level (asthey are happening within the same household), there exists a huge age variation of intra-household transfers. The intra-household transfers are estimated indirectly by assuming that a household member whose private consumption exceeds his or her disposable income is in deficit and has to receive transfers from other household members who face the surplus. If the total deficit of the household exceeds the total household's surplus, the household head has to finance the gap by, for example, borrowing assets.

4) Gender disaggregation

The gender-specific NTA results are estimated in a similar way to those of the standard NTA. The procedures are based on the approach of Donehower (2014). When using the survey data, the only difference in the age profile estimation is, that we need to calculate age- and gender-specific averages, instead of

only age-specific averages. Next, to estimate gender-specific public consumption on education, we use age- and gender-specific enrolment rates. Furthermore, the data on public health expenditures that we received from the AWG, are also disaggregated by gender. Finally, all the gender-specific age profiles are adjusted to match the standard NTA age profiles. Even though AGENTA data explorer includes gender-specific results for 25 countries, in this paper, we use the data for only 14 countries, for which fully comparable NTTA results are estimated and published on the data explorer as well. The NTTA are estimated in a comparable way for 14 EU countries only due to data limitations. For more details see Vargha et al. (2016).

2. National Time Transfer Accounts (NTTA)

The market approach of estimating economic flows clearly provides answers to many questions regarding population ageing. However, if we include the gender dimension into the analysis as well, we should bear in mind that SNA and therefore also NTA do not include the value of unpaid household work. Because women still provide more of the unpaid household work than men do (Miranda, 2011), using only the market approach would give a misleading picture of gender differences in production and other contributing activities to household members'welfare (e.g. cleaning, cooking, etc.). To correct for the gender bias,

the results of NTA by gender are combined with the NTTA results. The NTTA results are estimated based on Donehower (2014), whereas specifics of the European NTTA results are given in the European NTTA Manual (Vergha et al., 2016).

The NTTA age profiles are estimated in the following way: first, we need to define the time spent on different household production activities by age and gender using time use survey. In the European context the Harmonized European Time Use Survey (HETUS) Web application is used. In general, three different age profiles of household production are distinguished: general housework, childcare, and inter-household labour. General housework includes all household production activities other than childcare, whereas inter-household labour includes household activities carried out for other households. Secondly, we need to estimate the consumption of goods and services produced through household work. To allocate the goods and services produced among the household members, an imputation method is used. The age profiles based on time use surveyshave been imputed into the representative samples, such as EU-SILC dataset. The imputation is based on the information on the age and gender of the household members and the information about the household composition. Finally, the net time transfers, which are a non-market counterpart of the LCD from the NTA, are estimated as a difference between individual's consumption and production.

To combine the NTA and the NTTA results, the NTTA results are usually, aside from being presented in minutes per day, also presented in monetary values. However, the AGENTA data explorer includes monetized values of the NTTA results for the year 2002 only. To make the NTA and NTTA results comparable, we monetize the time spent on production and consumption using country-specific gross hourly wages of elementary occupations in 2010 (Eurostat, 2017).

Consumption, labour income, and economic life cycle

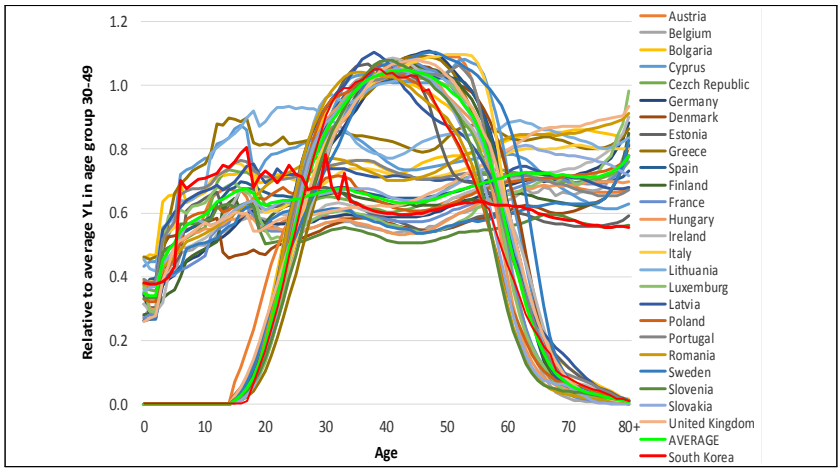
The economic life cycle exists due to different age patterns of consuming and producing over the life cycle. Figure 1 shows the age patterns of consumption and labour income for all 25 EU countries. To achieve comparability among countries, the values are presented relative to the average labour income for ages 30–49. With this we eliminate cross-country differences in inflation, exchange rates, levels of income, etc. The age group 30–49 is selected because it is not much affected by the decisions of leaving school, entering the labour market, or retiring (United Nations, 2013) and therefore being suitable for cross country comparison.

The age profile of labour income starts to increase after the age of 15, when individuals start entering the labour market.

After the peak during prime ages, labour income starts to decrease primarily due to lower labour market participation ratesfor the elderly. Whereas the labour income age profile has a typical bell-shaped distribution, the total consumption (including public and private consumption) is rather stable across all ages, with exception of two peaks: the first one at young ages due to high public education expenditures and the second one for the elderly due to high public health and long term care expenditures.

Individuals at young and old ages face a life cycle deficit (LCD) because their consumption is greater than their labour income. On the other hand, during working ages, individuals produce more than they consume and therefore face a life cycle surplus (LCS).

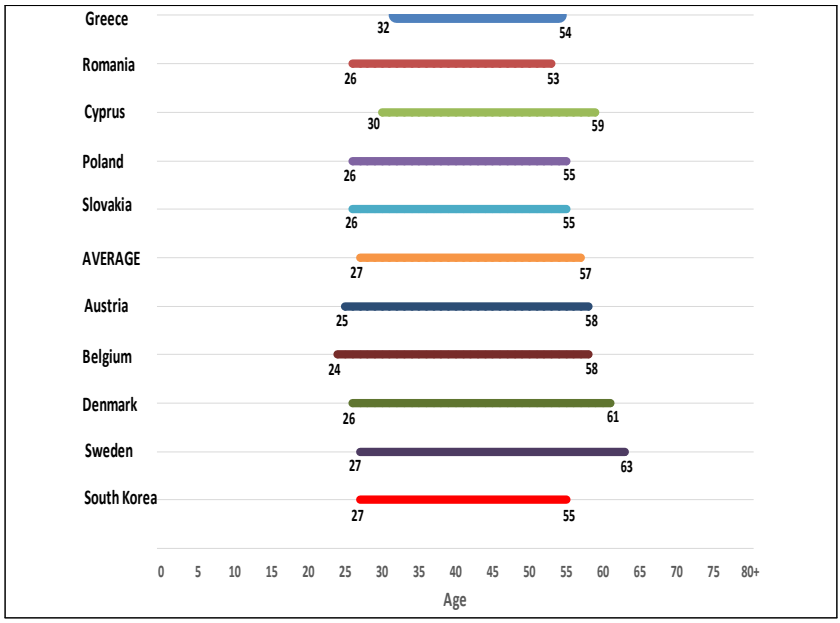
[Figure 4-1] Age profiles of labour income and consumption for 25 EU countries, 2010



Source: *AGENTA, 2018.*

Figure 1 reveals that in all EU countries the labour income exceeds consumption in an age range that is shorter than 45 years as conventionally assumed (from 20 to 64 years of age). Therefore, taking into account the actual age patterns of consumption and production will result in different size and trajectory of economic dependency over time.Even though the pattern of the economic life cycle is in general similar across countries, there are still large cross- country differences: (1) in the age span of negative LCD (i.e. positive LCS) and (2) in the size of the positive LCS.

[Figure 4-2] Age span in which individuals are net supporters (they produce more than they consume), EU countries, 2010



Source: *Istenič et al., 2017; author's own calculations.*

In Figure 2, we show the age span in which individuals are net supporters (i.e. the age span of positive LCS) in the selected EU countries. In Belgium and Austria, the young already start to be economically independent at the ages of 24 and 25, the youngest among all EU countries. In contrast, in Greece, the economic independence of the young starts only at the age of 32. Relatively low employment rates and relatively high consumption compared to labour income, results in the shortest age span of LCS in Greece, accounting for only 23 years (between ages 32 and 54). A relatively short age span of LCS is also characteristic of Romania, mainly resulting from relatively low ages at which the elderly become dependent. Relatively early retirement is also characteristic of all post-socialist/post-communist EU countries, such as Poland, Slovakia, and Slovenia. In contrast, individuals stay economically dependent up to higher ages in Cyprus, Denmark, and Sweden. Denmark and Sweden are also those countries in which the age span of LCS is the longest among the EU countries, accounting for 36 and 37 years, respectively. We add also the results for South Korea based on profiles that are available at the www.ntaccounts.org webpage. The age span of positive LCS is one of the shortest compared to the EU countries.

Economic dependency across EU countries

The share ofelderly is projected to increase strongly, whereas the share of working age population is projected to decline. This will pose strong pressure on the sustainability of the public system, on the ratio between production and consumption in general and it will also have broader economic consequences. In this section we focus on cross-section country comparison of the economic dependency based on labour income and consumption to see characteristics of individual country relative to other EU countries.

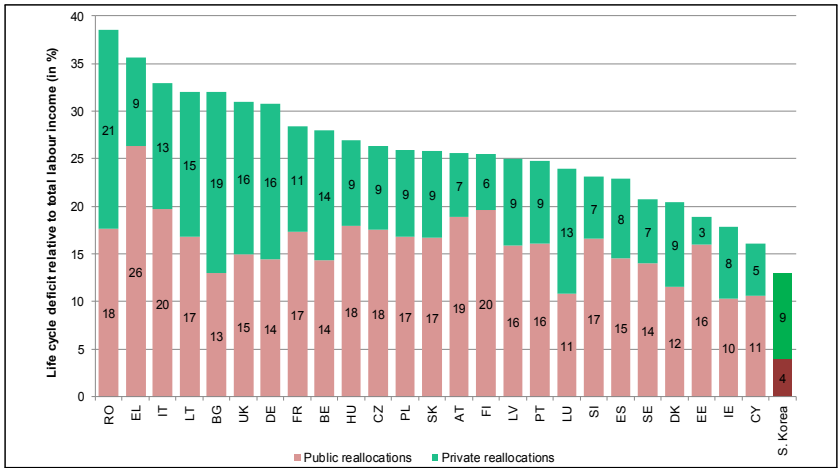
1. The life cycle deficit and its financing for the elderly

We only analyse the LCD for the elderly and not for the young, since the share of young is projected to stay stable over time. Figure 3 shows the size of the aggregate LCD for the elderly. The aggregate LCD is calculated as the sum of products between age-specific positive LCD values and the age-specific population. To make results cross-country comparable, we express the aggregate LCD relative to the aggregate labour income. The indicator shows how much of the total labour income is needed to finance the consumption of the elderly that is not covered by the elderly's own labour income.

Figure 3 reveals that there are huge cross-country differences

in the size of the positive LCD for the elderly. In 2010, the LCD of the elderly accounted for 16-19% of the total labour income in Cyprus, Ireland, and Estonia and up to 36-39% of the total labour income in Greece and Romania.

[Figure 4-3] Financing the difference between consumption and labour income of the elderly, EU countries, 2010



Source: *Istenič et al., 2017; Sambt et al., 2017; author's own calculations.*

*Note: RO = Romania, EL = Greece, IT = Italy, LT = Lithuania, BG = Bulgaria, UK = United Kingdom, DE = Germany, FR = France, BE = Belgium, HU = Hungary, CZ = Czech Republic, PL = Poland, SK = Slovakia, AT = Austria, FI = Finland, LV = Latvia, PT = Portugal, LU = Luxembourg, SI = Slovenia, ES = Spain, SE = Sweden, DK = Denmark, EE = Estonia, IE = Ireland, CY = Cyprus.

However, to comprehensively analyse the economic consequences of population ageing, we mustalso consider sources through which the LCD is financed. In European countries, the elderly mainly rely on public transfers (especially in the form of public pensions) and to some extent also on private ABR (e.g. private pension funds). The third option of financing are private transfers, but in most countries they represent only a relatively negligible source of LCD financing for the elderly. The exceptions are Lithuania, Romania, Latvia, and Bulgaria, where private transfers represent 6%, 8%, 9%, and 15%, respectively, of the total reallocations for the elderly (Istenič & Sambt, 2019). In Figure 3, we distinguish between public reallocations (primarily consisting of public transfers) and private reallocations (primarily consisting of private ABR) as sources of LCD financing for the elderly. In countries where the elderly primarily rely on private reallocations, the sustainability of the public finance system is less jeopardized by population ageing. Such examples are the UK, Germany, and Luxembourg. In contrast, in countries such as Greece, Austria, and Estonia, public reallocations prevail, meaning that in these countries, the public sector is much more vulnerable to population ageing. In this respect South Korea is doing very well. The LCD of elderly relative to the total labour income in the country is much lower than in EU countries. On top of that it is only in small share financed from public transfers.

2. The increased labour market participation rates as a measure for improving sustainability

The strategies that could already in the short run reduce the negative consequences of population ageing, particularly its effect on the sustainability of total consumption relative to total labour income, are especially 1) to increase the labour market participation rate of the youth and the elderly and 2) to increase the ability of the working-age population to support others (i.e. by increasing the size ofthe LCS) (Hammer, Prskawetz & Freund, 2015; Loichinger et al., 2017; Sambt, et al., 2017). It turns out that EU countries could practically mitigate the effect of population ageing by undertaking the labour income age profile of Sweden, where old age individuals stay in the labour market for around 5 years longer than in the majority of other EU countries (Loichinger et al., 2017; Sambt et al., 2017).

Past NTA research shows that the size of the LCS is particularly high in countries where women's contribution to the total LCS is higher (Hammer et al., 2015; Sambt et al., 2017). These are countries in which women's labour market employment rates are higher. In EU countries in general, the employment rate of women is still much lower than of men. In 2017, 66.5% of women and 78.0% of men aged 20-64 were employed in EU-28 countries (Eurostat, 2019). Therefore, as a possible measure to increase the sustainability is the promotion of

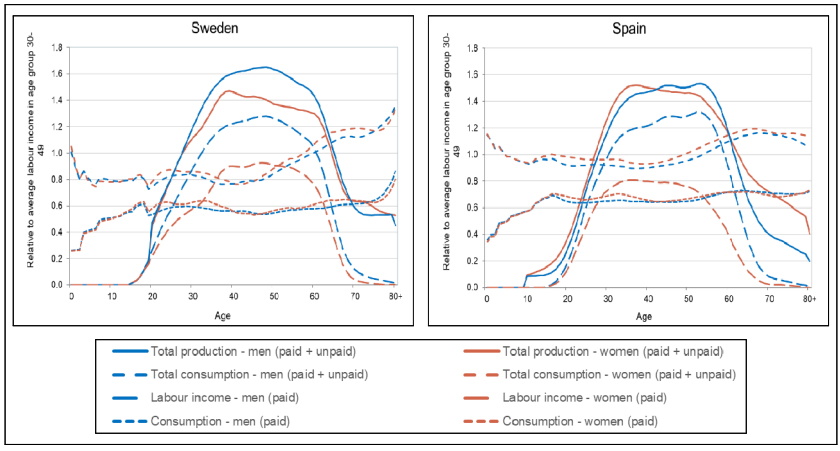
women's labour market participation (Sambt et al., 2017). However, we should be careful when making those conclusions. Even though on average EU men earn more on the market than women, women on average spend much more time performing unpaid household work (Hammer et al., 2015; Istenič et al., 2017). Therefore, the total amount of work,market and household work combined, should be closely monitored. Otherwise we could potentially put an extra workload on women who would be already providing considerably more work than men.

Figure 4 shows the income and consumption by age and gender for the two selected countries, Sweden and Spain, reflecting institutional differences between the northern and southern EU countries. We show the market values of labour income and consumption, as well as the total production and total consumption, calculated as a sum of market values and the monetary values of unpaid household work.

In both countries, women's labour income is lower than that of men. Thegender difference in the labour income results from lower employment rates of women, as well as the gender wage gap, presenting the wage difference of fully employed men and women. The gender difference in the labour income is smaller in Sweden, where gender equality is traditionally promoted. Although there are substantial gender differences in the labour income in both countries, the gender difference in the consumption is less pronounced, mainly appearing during the

child-bearing period as a result of higher health expenditures of women. The gender difference in the LCS thus mainly results from the gender differences in the labour income. In Sweden the labour income of women exceeds their consumption between age 33 and 62. Compared to Sweden, women's LCDin Spain is negative for a shorter age span (between ages 29 and 53) and it is also much smaller in magnitude. This shows the encouragement of the state to promote women's independence in Sweden (Istenič et al., 2019).

[Figure 4-4] Consumption and production by age and gender, Sweden and Spain, 2010



Source: *Istenič et al., 2017; Vargha et al., 2016; Eurostat, 2017; author's own calculations.*

After including the monetary values of unpaid household work, the gender differencesin the total production (income) become smaller in both countries. However, the results differ

between countries. In Spain, the gender difference in time spend on unpaid household activities reaches its peak in the 50s, when women spend approximately 4.5 hours more on unpaid work than men do. The gender equality encouraged in Sweden results in the comparatively smaller gender difference in unpaid production, with a maximum difference of approximately 2 hours at age 31 (Isteničet al., 2019). Whereas in Sweden, the gender differences in total production remain large even after including unpaid household work, the gender differences in Spain practically disappear. This means that in Spain lower labour income of women is compensated with their higher production in the form of unpaid household work.

Table 1 shows the gender-specific aggregate LCS for 14 EU countries, for which both NTA and NTTA data are available. The gender-specific aggregate LCS is a product between the gender-specific per capita LCS and gender-specific populatio n*for ages at which the average labour income exceeds the consumption. The aggregate LCS is expressed relative to the aggregate labour income and shows the total labour income available for supporting dependent population, separately estimated for both genders. The results are first presented without the monetary values of unpaid household work (denoted as LCS) and then by including it (denoted as total LCS).

* To facilitate comparison among countries, the standard European population is used (Eurostat, 2013).

The LCS of men ranges from 8.3% of the total labour income in Lithuania up to30.3% of the total labour income in Germany. The LCS of women ranges from 0.6% of the total labour income in Italy to 14.3% of the total labour income in Slovenia. Even though in all countries the LCS of men is higher than that of women, there are pronounced cross-country variations in the gender differences in LCS. The women to men ratio accounts for 2.5% and 2.9% in Italy and the UK and to 49.1% and 62.0% in Lithuania and Slovenia. When the monetary values of unpaid household work are included, the gender differences in LCS are reduced in all the countries. Although the gender difference remains high in the UK even after including unpaid work (women contribute 37% of what men do), in Italy, the women to men ratio increases substantially (accounting for 86.1%). Lithuania and Slovenia remain at the top of the ranking with the highest relative contributions of women. Lithuania and Slovenia also represent countries in which women's contribution is even higher than the contribution of men after including monetary values of unpaid household work. Unfortunately, this time we cannot add the results for South Korea because all the required data for those calculations are not available.

〈Table 4-1〉 Gender-specific life cycle surplus, EU countries, 2010

Country	Life cycle surplus as % of labour income			Total(including unpaid household work) life cycle surplus as % of labour income		
	Men	Women	Women to men ratio (%)	Men	Women	Women to men ratio (%)
Belgium	28.1	7.7	27.4	29.1	19.0	65.2
Bulgaria	15.1	1.7	11.6	14.1	9.8	69.4
Estonia	23.5	5.4	22.8	23.6	13.3	56.3
Finland	20.3	7.9	39.0	21.9	18.8	85.6
France	26.3	6.4	24.2	26.7	17.5	65.5
Germany	30.3	2.2	7.3	31.4	12.6	40.1
Italy	24.6	0.6	2.5	20.6	17.7	86.1
Lithuania	8.3	4.1	49.1	8.0	10.3	128.8
Latvia	16.3	3.9	24.0	14.9	10.1	68.0
Poland	23.8	3.0	12.5	24.7	14.9	60.5
Slovenia	23.1	14.3	62.0	23.3	24.4	104.7
Spain	23.8	3.6	14.9	20.8	18.7	89.7
Sweden	25.5	10.3	40.5	29.2	20.2	69.2
UK	27.4	0.8	2.9	28.3	10.5	37.0

Sources: *Istenič, 2019a, 2019b.*

Projecting future economic dependency

After presenting the cross-sectional comparison of EU countries in 2010 now we focus on the projections. It is the future demographic development that raises worries about the (un) sustainability of the consumption relative to labour income. Therefore, in this section we provide projections of future development in economic dependency given the above presented cross-sectional patterns of labour income and consumption and we apply them on the latest Eurostat's population projec-

tions EUROPOP2018.

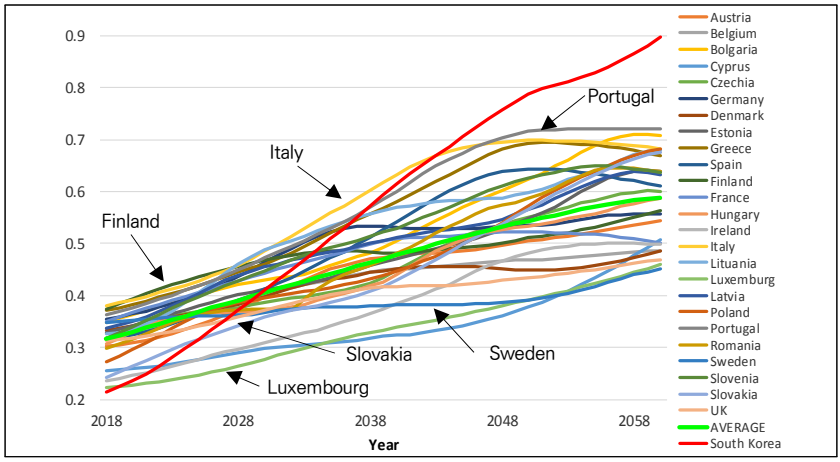
The longevity increase in the last 200 years is remarkable. The worldwide highest life expectancy is constantly increasing by about 2.5 years per decade for almost 200 years. The number of years a woman can expect at birth has almost doubled – from around 45 years for Swedish woman in 1840 (Roser, 2019) to 87.3 for Japanese woman in 2017 (OECD, 2019). According to the EUROPOP2018 population projections the impact of sub-replacement fertility, increasing longevity and positive net migration will largely cancel out from population size point of view. Even by the end of the 21stcentury the EU-28 population is projected to be 493 million, which is only a 4% drop compared to 512 million in 2018. However, the composition of the dependent older people relative to the working age population will change dramatically which will have impact on the sustainability of the public system and the economy in general.

1. Old-age dependency ratio

In Figure 5 we present the "old-age dependency ratio" (OADR) showing the number of individuals aged 65+ relative to the number working-age individuals 20-64, multiplied by 100. The alternative would be to show the "total dependency ratio" that relates all dependent individuals (the young and the elderly) in the working-age population. However, in all EU countries the

share of young (aged 0-19) does not change much during the projection period and therefore has only small impact on the changes in dependency ratio, therefore we show the OADR only.

[Figure 4-5] Old-age dependency ratio (P_{65+}/P_{20-64}) for EU-28 countries and South Korea



Source: *Eurostat, 2019; United nations, 2020.*

The elderly relative to the working-age population increase from 31.7% in 2018 to 58.7% in 2060. There are large differences among countries in both the initial level of the indicator and the relative increase during the projection period. Luxembourg has the lowest OADR in the initial year but also at the end of the projection period because of the specific nature of the country -attracting people during their working age who are going back to their countries once they retire. Slovakia has one of the lowest OADR in 2018 but it is projected to increase to

one of the highest OADR in 2060 due to very low fertility and rapidly increasing longevity. On the other side of the spectrum, Italy and Portugal have among the highest OADR in the entire projection period due to very low fertility in the past couple of decades and by having high longevity, especially Italy with one of the highest longevities worldwide. Finland and Sweden, on the other, with high fertility and high longevity have a high OADR in 2018 but during the projection period the increase is modest, especially in Sweden that has the lowest OADR in 2060 among all EU-28 countries. Compared to the EU countries South Korea really stands out. In 2018 SouthKorea had lower old-age dependency ratio than any EU country, but in 25 years it is expected to have the higher old-age dependency than EU countries. Persistent extremely low fertility and high longevity in South Korea will take the value of this indicator to very high levels.

Until now we have compared the age patterns of production, consumption transfers for 2010 to identify the characteristics of individual EU countries. However, as presented by the old-age dependency ratio based on the EURUOPOP2018 population projections, countries strongly differ in future population changes. Therefore, now we will apply the NTA age patterns of labour income and consumption on EUROPOP2018 population projections. This way we provide a general indicator of the future dependency.

2. NTA dependency ratio

The impact of the changing demographic age structure depends on the institutional settings in the economy whereby the central roles play the age patterns of labour income and consumption. Population ageing is less of a problem in countries where individuals enter the labour market early and they withdraw late. On the other hand, a high consumption over the entire life cycle and especially high health and long-term care expenditure at higher age will have negative impact on sustainability. In the NTA dependency ratio (*NtaDR*) we take into account actual extent of consumption and production at each age and therefore actual extent of (in)dependency. This time we include in numerator the entire dependent population (the young and the elderly). Technically, we calculate total consumption (C_i) and total labour income (YL_i) at each age by multiplying per capita age profiles with the population and then we sum up positive deficits for all ages. As denominator we use the total market labour income in the country, since the labour income is a standard denominator in NTA analyses.

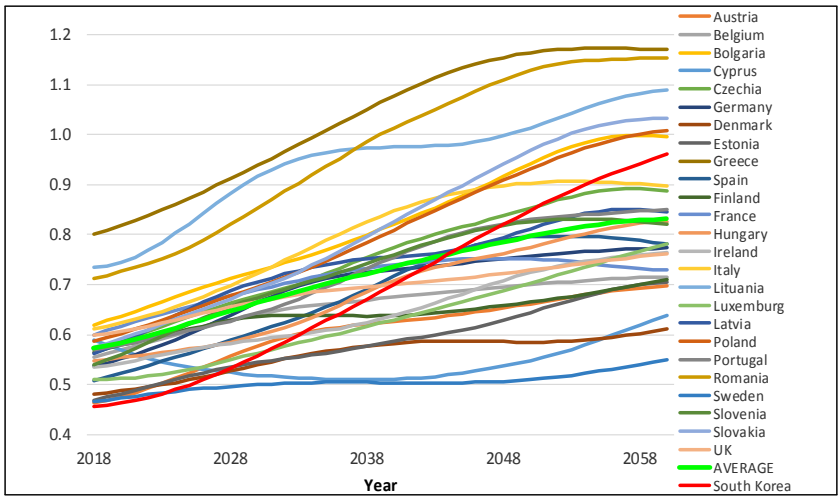
$$NtaDR = \frac{\sum_{i=0}^{L}(C_i - YL_i) + \sum_{i=U}^{80+}(C_i - YL_i)}{\sum_{i=0}^{80+}(YL_i)}$$

In Equation 1 C denotes consumption and YL stands for labour income – both in the market part of the economy. Also,

both categories are expressed as totals, already multiplied with the number of people in corresponding age groups. The $NtaDR$ represents an exercise in which we assume that per capita age profiles of consumption and labour income stay fixed over time –i.e. that cross-sectional and longitudinal age profiles are the same, which is a strong assumption.

Once we introduce actual age patterns of labour income and consumption by age, the results change considerably (see Figure 6) compared to the demographic old-age dependency ratio presented earlier (Figure 5). Countries with the highest NTA dependency ratio in 2018 are Greece, Lithuania and Romania. These are also the counties that face the highest increase in NTA dependency ratio during the presented projection period up to 2060. Romania is characterized with an early retirement and high level of consumption, especially at higher ages (Figure 1). In Lithuania a high consumption is even more pronounced, with a distinctively high consumption of young adults. In Greece the consumption is very high at all ages they enter the labour market the latest among all 25 EU countries.

[Figure 4-6] NTA dependency ratio (total positive LCD relative to total labour income) in 25 EU countries, 2010



Source: Eurostat, 2019; Istenič, Šeme, Hammer, Lotrič Dolinar, & Sambt, 2016; www.ntaccounts.org, 2019; author's own calculations

On the other side of the spectrum is Sweden since individuals stay in the labour market distinctively longer than in all other EU countries. Working longer is not only the most logical measure when longevity is increasing and population is ageing but also the most efficient one in the long run. In Sweden the NTA dependency ratio remains the lowest among all countries during the entire projection period with almost no increase at all. Similar holds for Denmark, also ranking high in how long people stay in the labour market, but unlike Sweden, Denmark faces some increase over the projection period. In the base year Austria has a similarly low NTA dependency ratio as Sweden because entering the labour market very early due to

the specific system of apprenticeship in their educational system (Sambt & Prskawetz, 2011). However, acting on the lower end of the labour income age profile is less effective than acting on the upper end, because in the long run increasing share of elderly is still pushing the NTA dependency ratio up. Therefore and because of low fertility, over time the NTA dependency ratio in Austria increases more than in Sweden. However, in Austria the *NtaDR* in 2060 is still lower than in most other countries. In Estonia the initial level of *NtaDR* is among the lowest due to the low consumption relative to labour income (Figure 1), but it increases substantially during the projection period because alsoa low consumption is less effective in coping with the population ageing than it is the late withdrawal from the labour market. Extremely strong population ageing and early withdrawing from the employment in South Korea are projected to have very strong increase of this indicator in the future.

Discussion and conclusions

The European Union is systematically monitoring the long-term sustainability of the public system. Calculations are prepared in collaboration with national experts and every three years presented in form of Ageing report. Comparability of the

results across countries is achieved by using the same input assumptions and having a thorough peer reviewing process for national simulations on pensions. The projected expenditures and revenues of the public sector are used to calculate the required maximum deficit or even surplus for the national public budgets. This is an important arrangement for timely acting on long-term sustainability since the politicians tend to be short sighted – their horizon of planning is often till the next elections only. This way the EU pushes national governments to act timely, whereas the comparable results and required rules give the national governments a good argument in discussing necessary changes with unions, other social partners and public in general.

The key input for the above-mentioned calculations are components of public expenditures and revenues decomposed by age. In this paper we demonstrate a potential of further decomposing all economic categories by age including private transfers and as far as possible also unpaid household work and gender dimension. In particular, we present fully comparable results of National Transfers Accounts (NTA) methodology for 25 EU countries in 2010. We provide a cross-country comparison of the results and propose possible strategies in the light of sustainability challenges that will bring population aging. The age-specific values of income, transfers, consumption, and saving help researchers and policy makers better understand

the economic consequences of population ageing. Moreover, to understand the consequences of population ageing on the sustainability of the public transfer system, both public and private transfer systems should be analysed and linked.

Using NTA methodology we define the periods in which individuals are net dependents (their consumption exceeds their labour income) and in which they are net supporters. We show that an average EU citizen's labour income exceeds his/her consumption between ages 27 and 57, which accounts for only 31 years. However, there are huge cross-country differences in the length of LCS, accounting for only 23 years (between ages 32 and 54) in Greece up to 37 years (between ages 27 and 63) in Sweden. Furthermore, we analyse the size of the LCD for the elderly in 2010 as well as its projected values in 2060. To fill the gap between consumption and labour income of the elderly, 16% of the total labour income is needed in Cyprus, whereas 39% of the total labour income is needed in Romania. In Sweden, the favourable population projections and low LCD for the elderly will lead to the smallest projected LCD among all the analysed EU countries. In contrast, the highest projected LCD for the elderly is characteristic of Romania and Greece.

The economic impact of population ageing on the sustainability of the public finance system is greater in countries where the elderly primarily rely on public transfers, like in Austria, Estonia, and Greece. On the other hand, the effect of

population ageing is smaller in countries where individuals rely more on private asset-based reallocations (for example, their own savings). Such countries are Germany, Luxembourg, and the UK.

To mitigate the effect of population ageing on sustainability of the public transfer system, two main strategies are suggested. The first is to increase the labour market participation for the elderly by following the Swedish system as a role model. This is also recommended for South Korea where early withdrawing from the labour market will otherwise not efficiently mitigate their extremely strong ageing process. This is especially true if in the future they will want to increase the consumption of elderly that is now lower than in the EU countries. Second is to increase the ability of the working-age population to support dependent individuals by increasing the magnitude of the LCS. The latter can be achieved also by increasing labour market participation rates of women. However, we claim that increased women's labour market participation is an effective measure to ensure the sustainability of the public finance system only in countries in which the contribution of women compared to men remains low even after including monetary values of unpaid household work. This applies, for example, to Germany, the UK, Estonia, and Poland. On the other hand, this policy measure is problematic in countries where the overall contribution of women is high, especially in Lithuania and

Slovenia, but also in Finland, Italy, and Spain. In these countries,the burden of women is already high, therefore a higher participation in the labour market would probably lead to less time spent on unpaid household work by women. The traditional patterns of division of labour between men and women within the households are hard to change in the short term, therefore this policy measure could lower the welfare of the population in these countries.

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V

Counting Women's Work in an Aging World

V Counting Women's Work in an Aging World

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Abstract

Standard measures of economic activity leave out one extremely important component of production and consumption—the unpaid care and household services that maintain and reproduce society. Unpaid care services represent a large portion of total work in our economies and are largely performed by women. Standard measures that ignore this kind of work underestimate women's economic contributions and misstate the true nature of productivity, dependency, and transfer systems. The invisibility of unpaid care work also hinders efforts to examine the gendered nature of economic activity and take steps to integrate men and women in all spheres of economic life more equitably. This paper reports on a methodology to understand and measure the gendered economy, combining gender-disaggregated market measures with unpaid care work estimates. As an example of how including unpaid care work

enhances economic demography, support ratios based on market work are compared with those based on unpaid care work. Dependency has different patterns in the unpaid care work economy and care-sensitive policies may be a way to meet some of the economic challenges posed by population aging.

Overview

Unpaid care work (UCW) creates the future. As infants, the most valuable investment our parents make in us is their time to care for us (National Transfer Accounts, 2017). Unpaid care work also undergirds the market economy, for who among us could hold a job without the mundane tasks of cooking, cleaning, laundering, or caring for us when we are sick? Certainly people could outsource these tasks to a paid provider, but evidence presented here shows that unpaid care work takes up close to the same amount of time as paid work and these tasks are nowhere in danger of being entirely outsourced to the market. It is notable then, that we know much more about market labor force participation than we know about participation in UCW. International databases are available to look up comparative data on market labor, by age, sex, and other characteristics for almost every nation on the planet. Government statistical agencies and researchers in the public and private

sectors make it their business to understand current patterns of market labor and forecast worker demand and supply to ensure economies can grow. Important economic analyses connecting demography and economic growth, such as the analysis of support ratios and demographic dividends, usually include only the measured, market-based aspects of production and consumption. Far less attention is paid to understanding the labor force involved in UCW which could also be a part of demographic dividends.

The first objective of this paper will be to use a methodology called the National Time Transfer Accounts to document current patterns of unpaid care work in a diverse array of countries. Patterns of UCW production, consumption, and transfers, in units oftime, will be shown by age and sex, and compared to market-based measures. UCW will be divided into two types: direct care for children, adults, and elders, and indirect care provided through unpaid housework and household management and maintenance. Showing the production and consumption patterns by age and sex will address such questions as which groups are consuming the most or least UCW, and which are producing it. The time spent producing UCW will also be examined relative to time spent in market work, both to gauge how large the UCW sector is compared to market work, and to see how gendered patterns of production vary in different places.

The second objective of this paper will be to combine those estimates of current patterns of UCW by age and sexwith population projections over the next fifty years to create projected care support ratios (CSR). These support ratios hold the age- and sex-specific patterns of the care economy constant but follow projected changes in national populations by age andsex. This represents a first step toward understanding the challenges and opportunities in the UCW economy in the future, whether future age structures will make it easier or harder for a population to continue to provide current levels of care based on the consumption needs of the population. These care support ratios are an UCW analog to the economic support ratios (ESR) long used in demographic dividend analysis. ESRs measure the extent to which age structure changes will make it harder or easier fora population to sustain its current pattern of consumption of market goods and services. A rising ESR indicates a demographic dividend in the market economy, a rising CSR indicates a demographic dividend in the household unpaid care work economy. Comparing the ESR and CSR across a diverse set of countries reveals how our aging future will enhance or hinder the maintenance of current levels of consumption in both spheres.

Data and methods

1. National Transfer Accounts

NTA methodology has been refined over many years and is documented on the project website (www.ntaccounts.org) and in a United Nations technical manual (United Nations, 2013). Well over 80 country research teams are involved in the NTA project and follow the methodology using available data in each country in order to understand each country's generational economy. The basic estimates produced are called age profiles, per capita age-specific measures of economic flows consistent with aggregate annual flows as measured in each country's national accounts. Age profiles are cross-sectional, rather than cohort measures. Developing an age profile in the NTA project has three main components: calculation of age-specific means, smoothing, and adjusting to national accounts aggregates.

Age means are calculated for each type of flow using an appropriate data source that indicates relative amounts of a particular economic activity by age. For private flows, household survey data are often available to indicate the amount of flow for each individual or the household as a whole. For household-level amounts, consumer weights are used to allocate most private flows to individuals. For other private flows for

which consumer weights are not appropriate, numerical methods based on observed household amounts and household structure are used to apportion amounts to individuals. If an age group is prevalent in households with generally larger amounts of a flow, that age group will be apportioned larger shares of household amounts, while age groups prevalent in households with smaller amounts of those flows will receive smaller shares. For many types of public flows, survey data are not sufficient because the spending or cost does not flow through household budgets. In this case administrative data from government sources are sought to indicate the age-specific average flows.

Once individual-level allocations are found, age-specific averages form the age shape. To reduce noise, the age schedule is smoothed over ageusing a cross-validation smoother (Friedman, 1984). Finally, the resulting smoothed age shape is adjusted up or down by the same factor at all ages so that the implied population aggregate matches that measured in national accounts.

To add gender into this framework, for most flows it is straightforward to add a sex variable to the calculations and produce two separate profiles for male and female for each measured age profile and adjust so that these sex-specific age profiles are consistent with a combined profile. As there are no sex-specific national accounts available consistently across countries, we rely on our surveys and administrative data to in-

dicate the correct proportion of flows in each age group that is for male or female.

Current methodology for NTA age profiles covers all flows measured in current accounts, but only those for consumption and labor income are used in this paper. NTA consumption includes both privately provided amounts, and publicly provided consumption of services such aseducation, health care, and general government services. NTA labor income includes wages and salaries as well as a share of the earnings generated by owned farms and businesses meant to represent labor's contribution to self-employment income. NTA estimates for many countries are freely available for download at the project website (ntaccounts.org).

2. National Time Transfer Accounts

The age- and sex-specific estimates of UCW presented here follow a methodology called the National Time Transfer Accounts (Donehower, 2019), or NTTA. NTTA follow the long-standing methodology that researchers have developed to estimate the production of UCW by using time use surveys to gauge how much time people spend in this type of production (Abraham and Mackie, 2005). Thistime is evaluated in the original time-based units for most of the analyses in this paper, but for comparison with monetarily-valued market flows, an imputed wage

for the UCW can be used. There are several different bases upon which to value the time, appropriate to different research questions. The basis used in NTTA is a specialist market replacement wage in which the wage of market workers who do a particular type of UCW is used to value time spent in that activity. When wage data by activity is limited, the generalist replacement method can be used in which a general housekeeper or domestic worker wage is used as the imputed value. Valuation by the replacement method is closest to that recommended to produce household production satellite accounts – UCW analogs to traditional market measures of labor covered in national accounting, such as Gross Domestic Product (Landefeld et al., 2009).

The NTTA approach adds the NTA framework to this methodology, explicitly acknowledging the role of age in determining much of the variation in economic activity. As UCW is largely driven by lifecycle processes of birth, marriage, household formation, aging, and death, a focus on the age dimension is necessary to understand UCW and make good policies around it. Much work on UCW has focused on a particular age group with a very wide age band, often those in their peak working or childbearing ages, rather than focusing on how UCW patterns change by age.

In addition to an improved focus on age, the NTTA approach allows us to see the whole system of exchange of UCW between

persons, not just production. To get the other side of the exchange, NTTA methodology includes an imputation of the consumption of UCW produced in households to individuals (methodology discussed in greater detail below). NTTA production minus consumption represents a net transfer of unpaid care work. An age group that consumes more UCW time than it produces must be consuming time provided by other age groups, while those that produce more UCW time than they consume must be giving that time to benefit other groups.

Applying this methodology to unpaid care work services reveals the same system of transfers between persons in the UCW economy that NTA has revealed in the market economy – young and old in different countries and regions have different levels of "dependency" relative to the productive capacities of peak age workers, and those peak age workers provide for the needs of young and old dependents in different ways and with different generationalarrangements.

To summarize, traditional methods to estimate household production satellite accounts are combined with NTA methods to disaggregate by age and impute consumption and transfers. This hybrid methodology is called National Time Transfer Accounts (NTTA) and has been developed by the Counting Women's Work project. Its strengths are that it brings a greater focus on the age dimension of UCW than previous research, making it amenable to the study of UCW in aging societies, and

that it includes methodology to impute UCW consumption which is harder to observe directly. The resulting estimates – age- and sex-specific average amounts of care produced, consumed, and transferred – can then be combined with population projection to reveal how the current system of UCW demand and supply will fare in the context of population age structure change.

The countries whose estimates appear in this work are all members of the NTA project, with country-based research teams. Counting Women's Work is part of NTA'sefforts to understand the gendered aspect of generational systems. Some of the NTTA estimates are available to the public and downloadable through the Counting Women's Work project website (www.countingwomenswork.org). This website also gives details on the research teams in each country.

1) Time use survey (TUS) data and methods to estimate UCW production

TUS data, either in the form of a complete time diary survey, or a survey module with sufficient questions about UCW activities, are used to estimate the production of UCW. Accepted criteria for identifying UCW activities have been developed in the process of creating household production satellite accounts (Abraham & Mackie, 2005), and this work follows those criteria.

We calculate average time spent in UCW activities by age and sex and smooth* those schedules over age to produce age profiles of the production of care separated by sex, for each country. Care is divided into two main types: 1. direct care for persons understood as service rendered in face-to-face interaction to help an individual maintain or enhance body or mind, and 2. indirect care through general household activities such as cooking, cleaning, and household management and maintenance that benefit all members of the household and keep it functioning.

The time use surveys available in the countries included here are of very different types. Most are time diary surveys in which individuals are asked to account for 24 hours of activity and their responses are coded using a coding scheme which covers all possible activities. However, some are activity-based time use surveys in which respondents were asked how much time they spent on particular activities. The comparability of these two types of surveys is certainly suspect, although the activity-based surveys used here cover a sufficiently detailed set of paid work and unpaid care activities that comparable activity groupings can be made. Within the diary-based surveys there is an additional issue of comparability introduced by different coding schemes used. These two issues – type of survey and di-

* As in NTA, NTTA smoothing is done with Friedman's SuperSmoother, a cross-validation smoother (Friedman, 1984).

ary survey coding scheme – introduce substantial uncertainty in cross-country comparison. We must therefore be cautious in interpretation and seek broad trends and patterns across countries instead of focusing on small variations. It should be noted that national accounts estimates are also based on country-level surveys of households, firms, and governments which vary substantially from country to country. Despite this potential for noise in the comparison, the general concepts measured are considered to be similar enough across countries to enable cross-country comparative macroeconomics. We rely on similar general adherence to the concepts of activities around market-based and unpaid care work to enable comparison of results from different time use survey instruments.

2) Household roster data and methods to impute UCW consumption

Some time use survey instruments indicate the exact member of the household who is the target of a direct care activity, making it possible to assign the UCW produced as the consumption of a particular individual. However, many do not have this feature. In order to estimate care consumption in a consistent way across different surveys, we will instead apply one consistent set of methods for imputing care in all countries. In this way, we do not observe the consumption of UCW

directly. Instead, consumption is imputed to persons in households based on the amount of UCW we observe as being produced in the time use survey and a set of assumptions about how the consumption of UCW is distributed.

For indirect care within ahousehold, i.e. the general activities within the household (cleaning, cooking, household management and maintenance, etc.), the time produced is divided equally among all household members, which assumes all household members benefit equally from this work. For direct care within a household, i.e. age-targeted care activities, this model is not appropriate, and numerical methods are used. Specifically, for childcare a household-level regression model is estimated on the survey data where we regress the household amount of childcare produced on the number of household members in each child age/sex group. The regression coefficients on each age and sex group then become consumption weights used to apportion the household amount of childcare produced in each household to each child in that household. Similarly for adult or elder care, we regress the household production of adult care on the number of adults in each age/sex group. Note that for either type of care, the producer of the care is not included in the regression estimation even if he or she is in the target age group because he or she is not a potential consumer of the care. For UCW that benefits non-household members, the production is distributed as con-

sumption to all persons in the target population, using the age profile of care provided within the household as proportional weights.

Once all UCW production is allocated to particular consumers, then producing the age- and sex- profiles is a matter of taking the age- and sex-specific average amounts consumed and smoothing over age to create sex-specific consumption schedules by age just as for the production schedules. For some surveys, all adults in the household provide time use data so that the survey can serve as both a production and consumption sample and overall population-level production is equal to consumption, except for small imbalances introduced by smoothing and sampling. In other surveys, not all potential care producers are sampled. In that case, population-level production estimates are weighted to be representative of the population average but the consumption is an underestimate because of the missing data from other household UCW producers. If the adults in the household who do give time use data are randomly selected, however, we can simply introduce a correction factor and inflate the consumption estimates so that they are equal in aggregate to the production estimates. All time use surveys have some age cutoff below which they do not collect time use data from household members, usually age 10 or age 15. We assume zero UCW production for those younger unsampled age groups.

Note that a full household roster, giving the age and sex of each member of the household of any time use respondent, is necessary for these methods just described. Some time use surveys collect this data, but for those that do not (Bangladesh and Thailand in the current set of countries), an alternate source of household structure data was used. Specifically, census samples available from the IPUMS International Database (Minnesota Population Center, 2018). These samples provide complete listings of household members by age and sex which can be combined with the time use data on production of UCW activities. The imputation is done by identifying as many matching variables in the time use survey and census sample as possible –age, sex, household size, relationship to household head, marital status, and education. The average amount of production of UCW activities is calculated from the time use surveyin cells defined by all categories of the matching variables and then imputed onto individuals in the census sample with the same categories of the matching variables. This puts the time use estimates into a context where the full household roster is available and makes it possible to impute consumption of UCW time. An alternative method would be to "hot deck" the imputation, but that is less necessary in this case because we are focused on average production and consumption and not inference or certainty around point estimates.

3) Estimating UCW transfers

Making the simplifying assumption that UCW time is consumed at the same time it is produced, total production of UCW time must equal its total consumption and no net transfers out of the system are possible.* This is true for the population as a whole but not for any individual or group within the population. Each age/sex group will have some net transfer made or received, calculated as the difference between total UCW produced and consumed, for direct, indirect, and total UCW.

3. Population projection data and support ratios

Once we are grounded in the empirical facts of the current market and UCW economies, we can then imagine how those economies might shift in the future. One way to do that is with the thought experiment "what if the market or care economy stayed as it is currently in terms of the average production and consumption by age and sex, but the numbers of people in those categories changed?" This is a straightforward calculation holding the production and consumption estimates constant while using a population projection into the future to change the population age and sex structure.

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* This is in contrast to market goods and services which can be sent across national borders or can be saved and stored for later as assets or borrowed in the form of debt, to consume now and pay back in the future.

The population projections come from the United Nations World Population Prospects database (United Nations DESA, 2019). The "medium variant"projection is used. The estimated population at 2015 is the starting point and the population by age and sex is projected to 2065. These projections continue the trajectory of population aging for most countries, with continuing gradual mortality decline and longer lives, and continuing gradual fertility decline for countries with above replacement fertility levels. For countries with below-replacement fertility, however, gradual fertility increases to replacement level are modeled, albeit with a very slow rate or fertility increase.

As discussed earlier, the ratio of aggregate supply to demand, or production relative to consumption, for UCW is here called a care support ratio (CSR). The ratio of aggregate amounts of labor income to consumption in the market economy is referred to here as an economic support ratio (ESR). Of course, we know that in the care economy, production must equal consumption in the aggregate by definition, but our projected CSRs will not equal 1 because the shares of consumers versus producers of UCW will shift. What does this mean, then? The CSR, rather than a model of a possible future, is instead an indicator of whether projected supply of care will be sufficient to satisfy projected demand. If not, there may not be enough care available for those in need, given current patterns of care consumption, giving rise to unmet needs for care. If the opposite arises, then time in the

future may be available for uses other than providing care as we observe in the current patterns of UCW production.

Charting the gendered economy

1. Production

Figure 1 shows the time-valued age profiles in hours per week for eighteen countries, for the year in which a time use survey was available in that country. There are several similarities across the countries despite the diversity of the sample by region, income level, and cultural background:

- women produce more UCW than men,
- there is a global or local maximum in women's UCW production between the ages of 27 and 38 (Vietnam is an outlier in this pattern with a local maximum at 22), and
- many countries have a "double hump" shape for women's UCW with another local maximum at older ages.

On the other hand, there is wide diversity in other aspects, such as the gap betweenmales and females, and the absolute level of production by men or women. In all likelihood, some of this variation is due to different time use survey instruments, different interpretations of the meaning of the questions by

survey respondents in different cultural contexts, or different coding of activities described by survey respondents by coders in different contexts. Vietnam in particular is a small sample and a very new survey instrument, and the results should be considered preliminary.

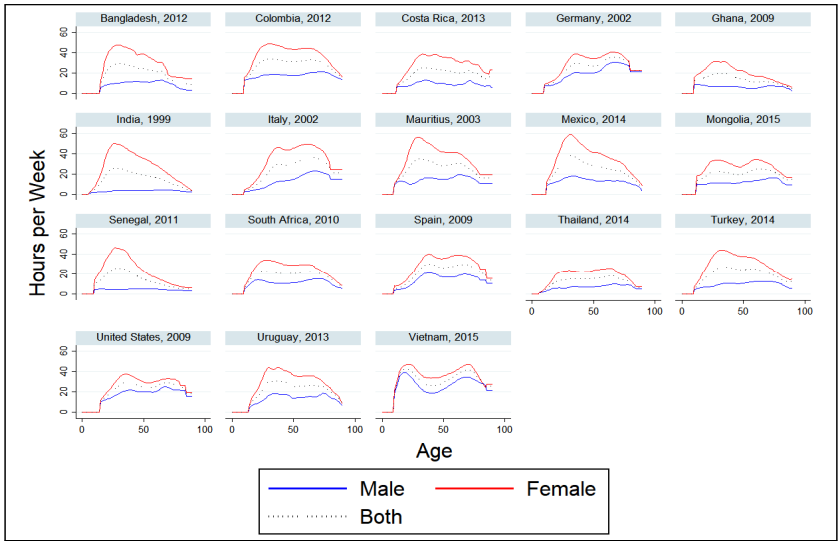
Figure 2 shows the same age profiles as in Figure 1 but for direct UCW only, that is the direct care of persons, not housework or other general household activities which benefit all household members equally. Certainly the Colombia survey instrument finds a greater baseline amount of direct care production across all ages than in any other country, and the Vietnam survey has a distinctive double hump-shape which may turn out to be more due to a small sample than an overall care system which is different than that in every other country, but in general the patterns are consistent: the largest amounts of care production are for women in the peak childrearing years. Men have a lower peak and in most countries it is a few years older than for women, possibly indicating that fathers are likely to help out more with the older children when mothers are busy with new infants.

Figure 3 shows the remaining portion of UCW: indirect care including general housework tasks and household maintenance and management. It has a very different age pattern compared to that of direct care work: there is generally more of it than for direct care work and it is much more likely to be done by

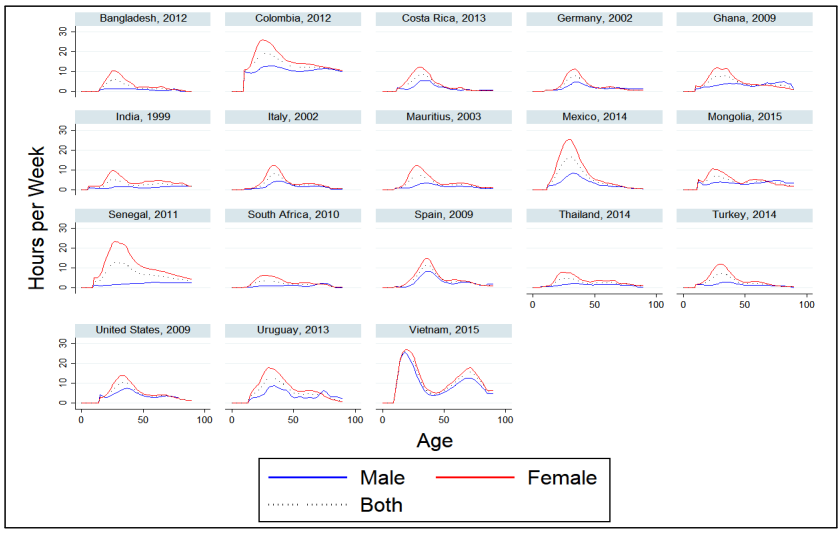
older persons than is direct care work. The maximum ages of the different types of UCW are shown in Table 1. In most of the 18 countries, women's peak age of direct care is in the late 20s to mid-30s, and for men it is a few years older. For indirect care, however, there is much less of a clear pattern by age and for many countries the peak level of production is at older ages.

One of the notable findings from the time patterns shown in Figures 1, 2, and 3 is just how much UCW older people produce. In the direct care figure, there is a small second peak for women in many countries around the ages of grandmotherhood. For indirect care, production actually rises with age in many countries until the oldest age groups when it does drop off in all countries.

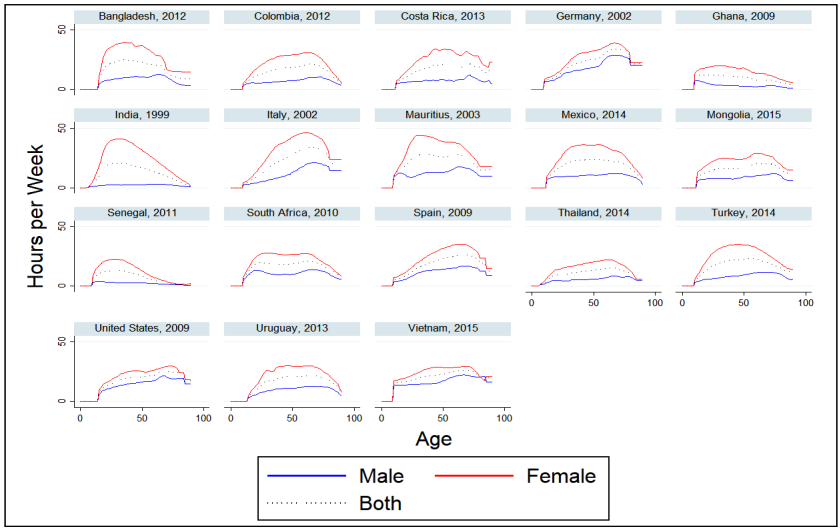
[Figure 5-1] Average amount of time spent in unpaid care work by age and sex, hours per week.



[Figure 5-2] Average amount of time spent in direct unpaid care work by age and sex, hours per week



[Figure 5-3] Average amount of time spent in indirect unpaid care work by age and sex, hours per week.



It is important to remember that these are cross-sectional estimates and so this rising pattern may be a cohort effect rather than a lifecycle pattern. In other words, younger people today may have different preferences for the products of unpaid care work compared to older persons. For example, younger cohorts may be happy with a passably clean house while older cohorts may prefer a spotless one. Productivity gradients may also be in effect: it likely takes longer to clean and fold a load of laundry at age 80 than it does at age 40.

〈Table 5-1〉 Age of greatest average UCW time, by type of care

	Direct		Indirect	
	Male	Female	Male	Female
Bangladesh, 2012	75	26	64	35
Colombia, 2012	33	25	73	62
Costa Rica, 2013	33	31	71	43
Germany, 2002	36	34	67	67
Ghana, 2009	81	27	10	30
India, 1999	90	25	63	31
Italy, 2002	38	34	67	61
Mauritius, 2003	36	28	63	31
Mexico, 2014	33	30	66	54
Mongolia, 2015	78	24	75	60
Senegal, 2011	60	27	16	28
South Africa, 2010	74	26	66	30
Spain, 2009	37	36	68	64
Thailand, 2014	33	24	68	62
Turkey, 2014	35	30	65	45
United States, 2009	37	33	67	73
Uruguay, 2013	34	30	64	47
Vietnam, 2015	18	20	67	69

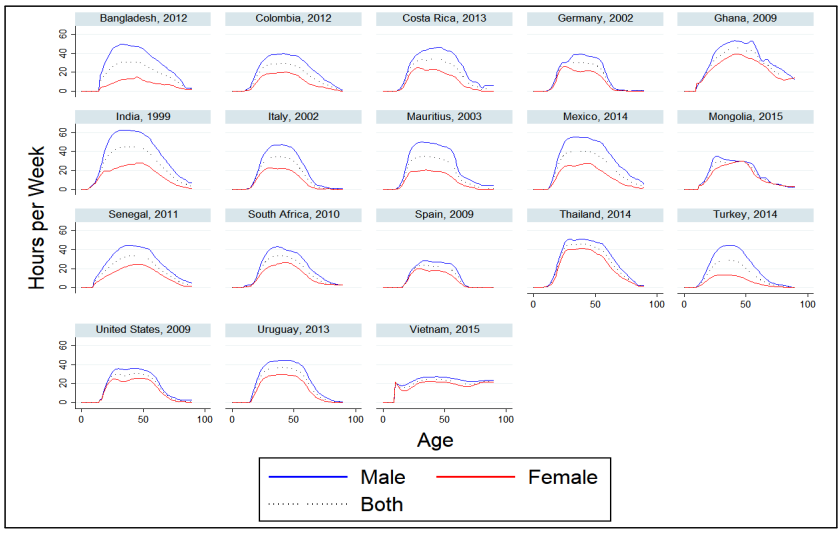
To contrast with the patterns of unpaid care work, Figure 4 shows the age profiles of market work for males and females. The

age shapes of the curves are regularly hump-shaped across all countries, and in every country at almost every age men perform more market work than women. One other important point to note about this market work figure compared to the UCW inFigure 1 is how much time we spend on UCW. This is summarized in Table 2 which gives the per capita average (across all age/sex groups) of time spent in market work or UCW. The ratio of these two averages is in the final column of Table 2, which shows that time spent in UCW ranges from 0.54 to 1.64 times that spent in market work. That demonstrates how important this sector of the economy is and highlights the need to understand its dynamics.

〈Table 5-2〉 Per capita hours per week by type of work

	UCW	Market	Ratio
Bangladesh, 2012	16.4	16.8	0.98
Colombia, 2012	24.2	16.6	1.46
Costa Rica, 2013	16.2	19.3	0.84
Germany, 2002	23.2	16.3	1.42
Ghana, 2009	11.4	21.2	0.54
India, 1999	14.0	25.3	0.56
Italy, 2002	22.9	17.8	1.29
Mauritius, 2003	22.6	20.0	1.13
Mexico, 2014	21.4	22.8	0.94
Mongolia, 2015	15.3	16.9	0.90
Senegal, 2011	12.6	14.9	0.85
South Africa, 2010	15.6	15.8	0.99
Spain, 2009	21.1	12.9	1.64
Thailand, 2014	12.6	28.8	0.44
Turkey, 2014	17.6	14.7	1.20
United States, 2009	19.3	17.6	1.10
Uruguay, 2013	19.0	19.5	0.97
Vietnam, 2015	27.7	18.0	1.54

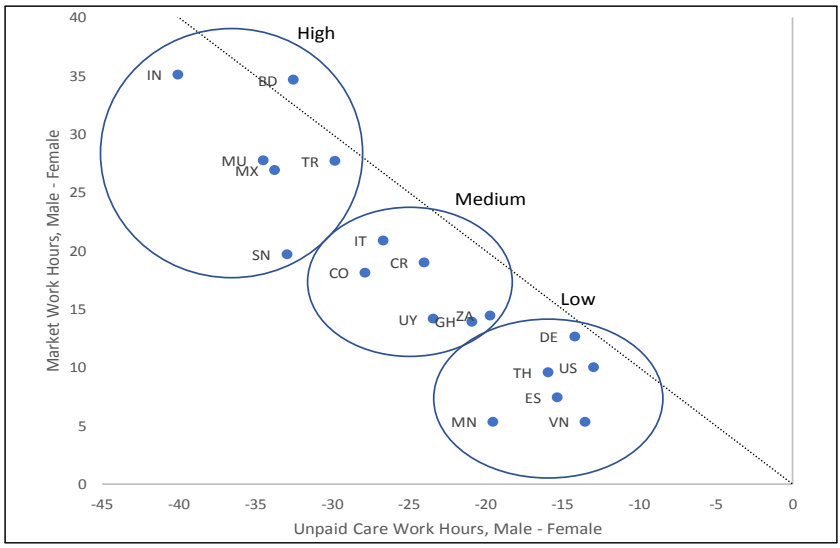
[Figure 5-4] Average amount of time spent in market work by age and sex, hours per week.



[Figure 5-5] Difference in average time spent by type of work, age, and sex, hours per week, male - female.

To examine the gender dynamics between market and UCW more closely, Figure 5 shows the difference between male and female for average time spent in both market work and UCW by age. Differences are plotted for the male minus female amount, so a line above zero means males do more, below zero means females do more. We see in this chart that in every country at every age, men do more market work, women more unpaid care work. One of the unexpected patterns seen in Figure 5, though, is the seeming symmetry around the zero line. This is related to what is often referred to as the "iso-work" phenomenon, wherein large gender differences in participation between the market and household spheres add up to strong patterns of equality in total work (Burda, et al. 2007). If we compared total work, women in most countries are doing slightly more total work, but this is not a universal pattern across countries or by all ages.

[Figure 5-6] Age-specific gender difference (male - female) in time spent by type of work and country, equal weighted average over ages 20-50.



Note: Three equal groups formed based on the sum of absolute values of gender gaps in market and unpaid care work represent degree of gender segregation in production between market work and UCW. Groups are high (IN - India, BD - Bangladesh, MX - Mexico, MU - Mauritius, TR - Turkey, SN -Senegal), medium (IT - Italy, CR - Costa Rica, CO - Colombia, UY - Uruguay, GH - Ghana, ZA - South Africa), and low (DE - Germany, MN - Mongolia, ES - Spain, TH - Thailand, US - United States, VN - Vietnam)

To explore this gender differentiation further, Figure 6 shows a scatter plot of the gender difference in market work versus UCW. The calculation includes ages 20-50 and is an equal weighted average of age profile values, so that population age

structures which vary from country to country will not affect the comparison. The differences are expressed as male minus female, so that the difference for UCW is negative on average while for market work it is positive. If the iso-work phenomenon were in effect, all of the points would line up on the dotted diagonal line at which adult men's excess market work time would exactly equal adult women's excess UCW time. If there were little gender differentiation in economic activity between the market and household/UCW spheres, then the points would line up at the origin where there would be no difference in men's and women's work time in either sector. What we see is that there is a great variation in the degree of gender differentiation from country to country, from Vietnam which is closest to the origin, to India which is the farthest away. We also do not see the iso-work phenomenon here, using this summary measure that averages across adult age groups. Instead almost all points are below the diagonal line, with the exception of Bangladesh, indicating that in this sample, adult women's greater amount of UCW is of higher magnitude than men's greater amount of market work. Three circles are drawn to divide the sample into three groups of highest, medium, and lowest levels of gender specialization between market and UCW spheres. The groups do not seem to correlate strongly with distance to the diagonal, revealing no strong correlation between specialization and disadvantage in terms of total work.

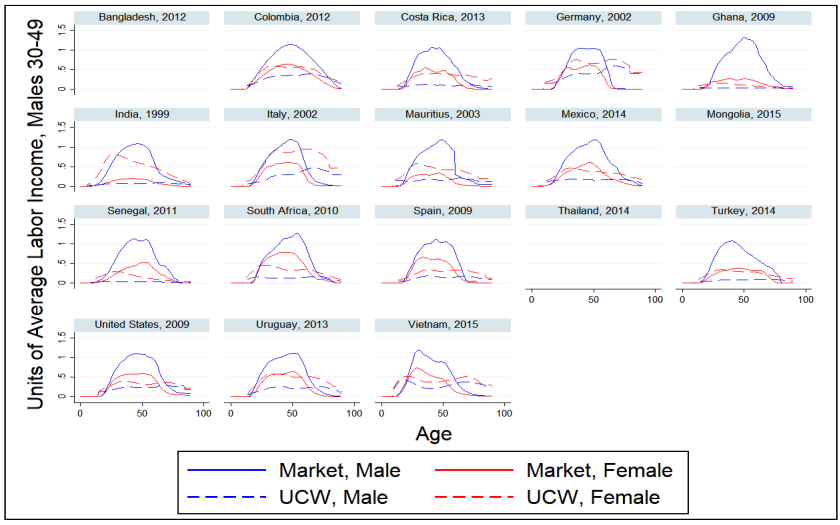
The methodology for NTTA does include a protocol to value UCW time by an imputed wage, which enables comparison of the gendered economic effect of wages. Figure 7 demonstrates this picture by charting the monetary profiles for both NTA labor income and NTTA production, standardized by the average market labor income of males aged 30-49. The units reflect a year of peak male earnings. (The sex-specific labor income profile necessary for the standardization is not available for Bangladesh, Mongolia, or Thailand.) As in previous figures, estimates for males are shown in blue, for females in red. Market labor income is shown as solid lines while wage-valued UCW time is shown as dashed lines. Standardizing on male earnings instead of both sexes combined means that the comparative measures are not impacted by relative male/female wages. If standardization were done on both sexes combined, some of the cross-country differences in gender gaps would be erased.

Figure 7 clearly reflects the generally low level of market wages for UCW, becausethe dashed UCW profiles are generally lower than the market labor income profiles. When we use these low imputed wages to value UCW, our estimates reflect the legacy of gender discrimination in the workplace, with historically female occupations earning low wages. Notable exceptions to this are Italy and Germany, where high minimum wages ameliorate this legacy somewhat.

While average earnings are generally lower for women in

market labor income compared to men, this includes many types of differences, all rolled into the labor income gap: differential labor force participation, gendered occupational segregation, different propensities to work part time, and then differential wages for an hour of similar work. While some would argue that only this last represents "real" gender discrimination in the workplace, each type of difference reflects the constraints on women from cultural practices around what types of occupations women should have, and also the fact that women in market work often must constrain their job search and job choices to work that can be combined with their societally sanctioned role as the main UCW provider.

[Figure 5-7] NTA market-based labor income compared and NTTA imputed wage-valued UCW production, by sex, standardized to average male NTA labor income age 30-49

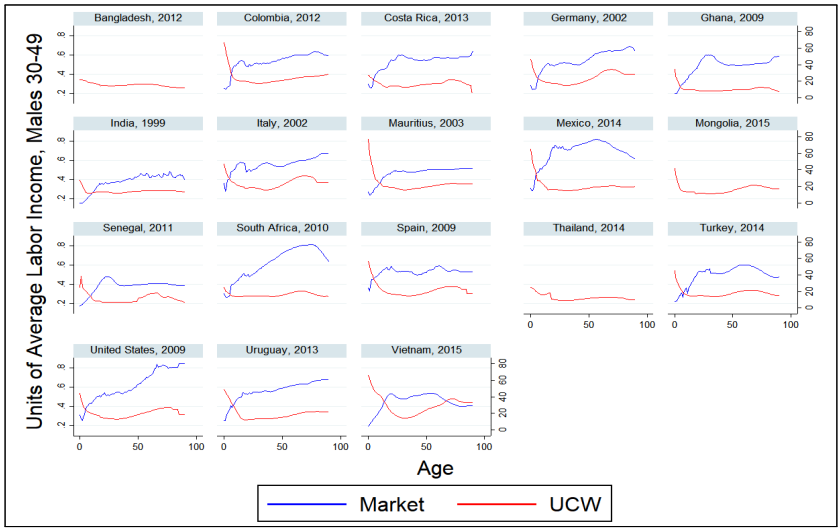


2. Consumption

Figure 8 shows the imputed age profiles of consumption, both for unpaid care (valued in time units) and in market goods and services (valued in standardized units of male labor income age 30-49). The two different types of consumption are graphed against different vertical axes so the difference in the age shapes will be more apparent.

Only single sex profiles are shown. The imputation by separate sex turn out to be very close, which could either be because there is not sufficient evidence in the data for sex differentiation of care consumption, or that the type of sex differentiation that does exist is not picked up by the methods we use. Those methods rely on differentiation across households of different age/sex distributions, but for persons in a household of same age, the imputation method we use would not be able to detect different levels for a same age male and female. For this reason, only the combined single sex age profile is shown. The consumption patterns seen still reflect a gendered economy, however, because of the gendered nature of who is providing most of the different types of consumption: men provide most of the market goods and services, women provide most of the UCW.

[Figure 5-8] Average consumption of market goods and services and UCW time, in units of average labor income for males 30-49 for market-based consumption, and hours per week for UCW consumption



Notes: Market-based consumption is scaled to average male labor income ages 30-49 and charted relative to the vertical axis on the left-hand side of the chart. UCW consumption is in hours per week and charted relative to the right-hand side of the chart. Bangladesh, Mongolia, and Thailand do not have market labor income currently available by sex, so the standardization to male labor income is not possible. Single-sex estimates are shown so as not to over-interpret minute sex-differences in consumption estimates which may be a lower-bound for actual gender differences due to limitations in the data and methodology.

What stands out most clearly in this picture is that the youngest children are the greatest consumers of unpaid care work and the least consumers of market goods and services. Looking at the other end of the age range, UCW consumption does rise somewhat by age group at the oldest ages in many of these countries, but nowhere do we see the amount of UCW consumed by elders come anywhere close to that consumed by

infants and young children. In consumption of market goods and services, however, the oldest age groups are the greatest consumers in many of the countries observed.

UCW consumption for infants may be much higher because they are more likely to have multiple persons caring for them at the same time, but the imputation method used here would add thoseoverlapping hours together. Some may consider this a double counting of care provision, but the child would still benefit in many ways from having multiple caregivers at a time, from having more attention, more interaction, and being able to hear more different types of speech and interaction than if there was one caregiver alone.

It is surprising how little eldercare consumption we see in these estimates. This may be because many elders remain healthy and so are not in need of much direct care. It may also be due to problems in time use survey instruments' ability to detect eldercare as thoroughly as it detects care of young children. Many eldercare activities could be coded as leisure time, such as talking on the phone with an elderly relative whilealso monitoring their wellbeing and assisting with household management tasks. It could also be harder to detect those very intensive eldercare episodes caused by health emergencies. If an elder is suddenly rushed to the hospital and then comes home andrequires 24-hour care for a brief time of recovery, that is a very unlikely time for the household to be participating in a

time use survey but represents a substantial time transfer. Or if adult children leave their own residence for an extended period of eldercare at the elder's home, they will likely have no chance of that time being captured in a time use survey. For these reasons, the lack of sharp increases in care consumed at oldest ages certainly calls for more study and replication on other datasets, especially those studies modeled on the Health and Retirement Study that focus on care needs of older persons more specifically than a general population time use survey.

3. Net transfers

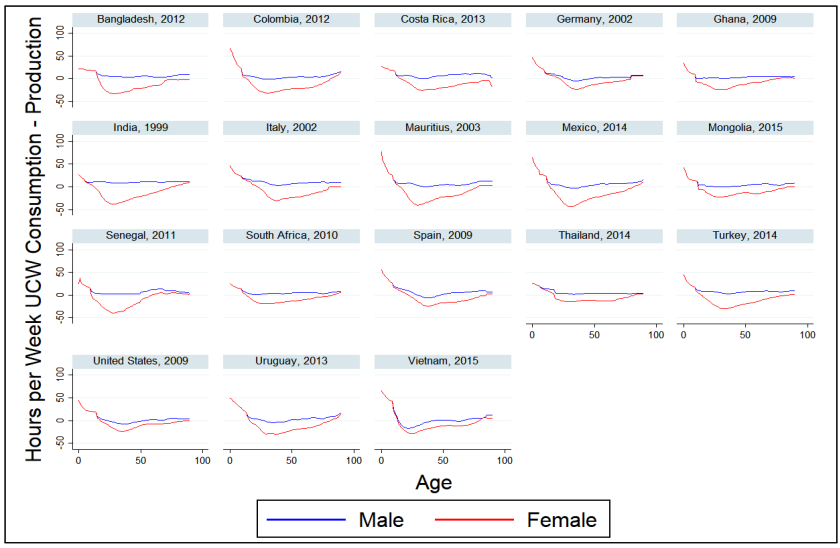
The difference between UCW consumption and production is net transfers. If we observe an age/sex group with consumption higher than production, then they must be getting a transfer to make that possible. In the market economy, the picture is more complicated because it is possible to store today's production as an asset and consume it at another time, or to borrow against assets or future production and consume tomorrow's production today. For time transfers, however, that is not possible. This is obvious for direct care as that involves interactions in the moment but conceptually less clear for indirect care. For example, I might clean the laundry today but my family will wear the clean clothes over the coming week. However, even for a situation like this, the time transfer is generally con-

sumed in the near-term, so we will make the simplifying assumption that all time transfers are consumed at the moment of production.

Figure 9 shows the age and sex dimensions of such net transfers in our sample of eighteen countries. What is abundantly clear from this figure isthat men hardly make any net transfers in any country or in any age group. The gendered nature of household production looks to be a very strong feature of economic and social organization across all of these countries, despite the huge variation in other social and economic characteristics such as income level, region, religious make-up, and fertility. Contrast Senegal and Italy, for example. Senegal is the highest fertility, youngest population in the sample and Italy is close to being the lowest fertility and oldest population (2010-2015 TFRs: Senegal 5.0, Italy 1.4, from UNWPP 2019 Revision). Despite the huge difference in population age structure and family size, their net time transfers by sex look startlingly similar. Not all of the pictures look the same however. Moving to compare Spain, the lowest TFR country in the sample at 1.3 children per woman in 2010-2015 (from UNWPP 2019 Revision), we see still the overall feature of women making more net transfers than men, but men do make net transfers in the age groups of peak childrearing work. Transfers are also less in magnitude overall and the degree of gender difference is less as well.

This suggests that the gendered economy is a stable feature of economic organization throughout the world, butthe degree of gender differentiation can vary greatly. It also suggests that any economic policy related to the labor force or household or family dynamics must be gender-aware. Men and women lead different economic lives, on average, and policy that does not take that into account is likely to miss its targets.

[Figure 5-9] Average net transfers of unpaid care work time by sex, hours per week



4. Dependency in market versus UCW spheres

Ideally we would have the net transfers of market goods and-services by sex as a picture to complement the UCW transfers

shown in Figure 9, but that work is ongoing to fully disaggregate market-based NTA accounts by gender. It is more complex than for UCW because it also involves transfers mediated by the state, in other words public taxes and transfers. We can be fairly certain, however, based on their much larger labor income that men are making most of the net transfers of market goods and services to children and women. What we can observe is the combined sex differences in dependency in terms of market goods and services compared to UCW.

Figure 10 shows estimates of the lifecycle deficit in the two different spheres of market goods and services versus UCW. The concept of the lifecycle deficit is directly related to dependency –positive values are resources which must be obtained through transfers in the case of UCW or transfers and asset-based reallocations in the case of market goods and services. Figure 10 shows clearly the different nature of dependency in these two spheres of economic activity. Elders are the source of the largest per capita lifecycle deficits in the market economy, but in the UCW economy in many countries, they are actually producing surplus into very old age groups. Children havelarge deficits in both spheres, but the UCW deficit is greatest at birth and declines steadily with age, whereas the market deficits for old people rise until they begin to enter the labor force.

The gendered economy in an aging future

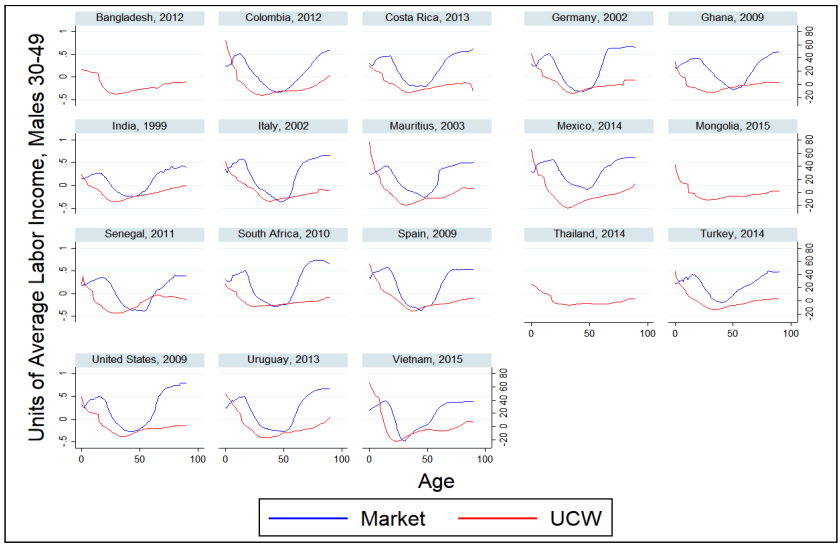
1. Gender, dependency,demographic dividends, and support ratios

Early work connecting demographic change to economic outcomes was based on dependency ratios – the population ratios of dependent young and old age groups to working age groups. The age groups were defined somewhat arbitrarily and applied across all areas in an analysis equally, regardless of how different age patterns of education, home leaving, family formation, and retirement might be from place to place. If the dependency ratio was falling, a population was said to be experiencing the demographic dividend.

Lee and Mason and collaborators developed a better way to measure dependency using real data (Lee and Mason, 2011; United Nations, 2013). This method produces estimates of the age dimension of economic activity called National Transfer Accounts (NTA), described previously. An age group's level of dependency in NTA estimates is its consumption minus labor income, a value called the lifecycle deficit shown as the blue lines in Figure 10. In demographic dividend analysis using NTA age profiles, the balance between consumption and production is often measured as the support ratio, although here I will refer to it as the economic support ratio (ESR) to distinguish it

from the care support ratio (CSR) that will be discussed later. A one percentage point rise in the ESR enables a percentage point rise in consumption at every age, all things being equal, without any increase in age-specific labor income necessary. A rising ESR indicates a demographic dividend, a falling ESR a demographic tax. Mason et al. (2017) showed in ESR estimates the degree to which different nations would be impacted both by their changing population age structures, but also by the generational economies that had developed and set the levels of production relative to consumption for different age groups. For most countries, the long-term outlook is that population aging represents a significant challenge to countries' ability to support the market-based consumption of future populations withtheir labor. However, compensating factors such as the ability to invest more in human and physical capital have the potential to ameliorate the situation somewhat.

[Figure 5-10] Lifecycle deficit (consumption less production) for market economy versus UCW, in units of average labor income for males 30-49 for market-based consumption, and hours per week for UCW consumption



Notes: Market based consumption less production is scaled to average male labor income ages 30-49 and charted relative to the vertical axis on the left-hand side of the chart. UCW consumption less production is in hours per week and charted relative to the right-hand side of the chart. Bangladesh, Mongolia, and Thailand do not have market labor income currently available by sex, so the standardization to male labor income is not possible.

If we think of unpaid care work as representing another sphere of economic activity, the population-weighted ratio of UCW production to consumption gives a care support ratio (CSR) that is similar to the ESR and a rising or falling CSR will represent a demographic dividend or tax in the unpaid care economy from population age structure change. A rising CSR means that population change will make current levels of UCW

consumption easier to sustain in the future. A falling CSR, the opposite. As mentioned previously, the CSR is not meant to reflect reality as the ratio will deviate from one in the projections, but in the real world we know the care economy will have to adjust so that aggregate production is always equal to aggregate consumption.

The ratios are calculated based on different units, the ESR based on monetary age-profiles and the CSR based on time-based age profiles. Because these are ratios the units disappear, and in general the monetary-valued UCW profiles have very similar shapes to the time-valued profiles because of relatively constant imputed wages over age. It is important to keep in mind, however, that a change in ESR will have different consequences than a changein CSR. Rising ESR means freed up dollars that are no longer needed to subsidize dependent age groups, by contrast rising CSR frees up time. Dollars can be used to pay for care that may substitute for UCW, just as time can be exchanged for money to purchase market goods and services. More complex models will be needed to understand how these two ratios may work together. The current research lays the empirical foundations for comparing the two.

2. Projected care support ratios

One reason that we should take note of the UCW economy has already been discussed –it represents a huge portion of the total activity in an economy, as shown by the ratios in Table 2. Another reason we should care about the UCW economy is that it is an age-driven system providing the care that children and elders cannot provide for themselves (although for elders the net need is much less). Any age driven system will be affected by change in population age structures and, with the global trend toward lower fertility and longer lives continuing, population age structures are projected to change a great deal in the future. As discussed in the introduction, these changes can be summarized using care support ratios. In our projected future populations, will there be enough unpaid care available for those who need it, given the current age- and sex-specific patterns of care consumption and production? The UCW age profiles showed how different countries have different levels of production and consumption of UCW time by age currently. When we combine that current picture with projected population age structures over time we see if future changes in population age structure will make this system harder or easier to maintain.

This thought experiment makes a strong assumption that there will be no substitution between unpaid care and mar-

ket-based care provision. We know, however, that such substitutions are likely and have historical precedent, with many societies growing the level of purchased care and household services substantially over time, although at different rates for different types of care. We will not be addressing that issue here, instead restricting the research question here to whether or not given current per capita consumption and production of unpaid care work, future populations will be able to meet the demand.

Figure 11 shows projected care support ratios of aggregate production relative to consumption in three different versions: the total UCW support ratio is shown in black, direct care in red, and indirect care in blue. The calculations begin in 2015 with the assumption that the system is in perfect balance: aggregate production equals aggregate consumption and all support ratios start at 1.0. Each year the population changes as in the UN WPP's 2019 medium variant projection. The new aggregate care support ratio goes up or down from 2016 to 2065 based on whether the population age structure is changing to favor production over consumption, or the opposite.

What do we observe? For the relatively young countries whose fertility is projected to fall, care needs will be easier to meet over time. In Bangladesh, Ghana, India, Mexico, Mongolia, Senegal, South Africa, and Turkey, the red line for the direct care support ratio increases steadily because the very time-costly

young children's share of the total population falls relative to their very productive parents and, to a lesser extent, grandparents. The blue lines for indirect care support ratios are mostly flat in these countries. This is mainly driven by the much flatter curves for both the production and consumption of indirect care relative to that for direct care. Flatter curves mean that age structure does not affect their balance over time as much as the highly age-differentiated curves for direct care. It is also impacted by the fifty-year time frame for observing change. In this time window, population aging will not be so acute yet for these young countries. Combining direct and indirect care then gives largely positively sloped lines in these young countries, but with slower growth than direct care alone.

For the countries which already have low fertility and relatively small cohorts of new infants entering, the picture is different. Their direct care support ratios fall somewhat over the fifty-year projection period. In Germany, Italy, and Spain, the share of time-costly children will not fall that much, but the oldest old shares will grow relative to the more UCW time-productive ages in mid-life, leading to relatively lower supply of direct care relative to the demand.

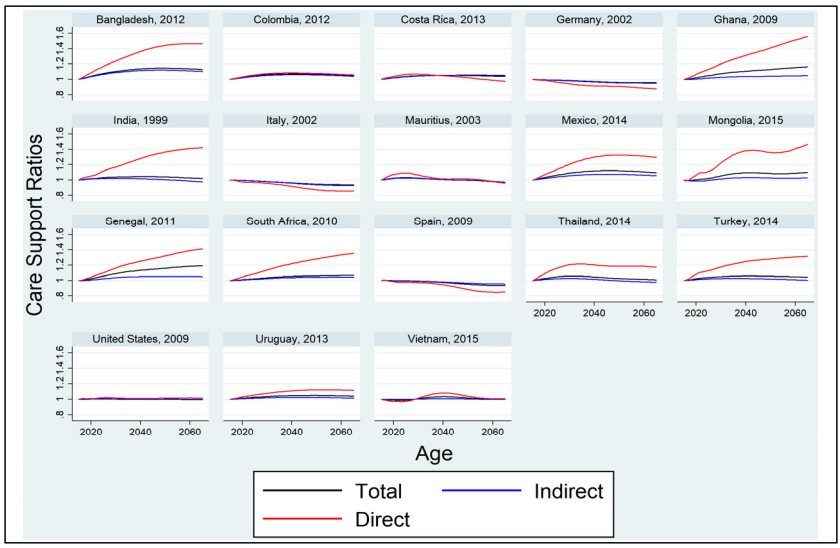
A few countries, such as the United States and Vietnam, remain quite stable. These countries seem to have a more diversified supply curve of care over age and sex.

3. Alternative scenarios for care support ratios

The analysis in the last section presented a very restricted scenario in which nothing changed in the unpaid care work economy other than the shares of the population by age and sex. Beyond this baseline scenario, many other scenarios can be imagined for how the UCW system might change in the future. Three simple scenarios are examined here:

- QQ tradeoff. As first imagined by Gary Becker (1960), instead of always preferring more children when they have more resources, parents may instead prefer to have fewer children butinvest more in each child. There is evidence that this quantity-quality tradeoff occurs not just with market inputs into children, but unpaid care work as well (Vargha and Donehower, 2019). We can turn this into a scenario of change in the UCW system byimagining that the direct care support ratio remains fixed, even as the number of children changes. In other words, the age profile of direct care production stays fixed, the consumption of direct care rises because fewer consumers share the same amount, but the ratio stays fixed. With no change in the direct care support ratio, the overall UCW support ratio changes due only to changes in the shares of indirect care demand and supply.

[Figure 5-11] Projected care support ratios, by type of unpaid care work, 2015 - 2065



- **Men increase UCW to equalize total work with women**. As demonstrated in Figure 6, in most of the countries in our sample, women do more total work hours than men, adding UCW and market work together. The differences are not huge, but they are consistent. What if men's UCW production increased so as to eliminate any gaps in total work? There would still be gender specialization, but no gender gap in total work time and smaller gender gaps in UCW time. (The increase in men's UCW is divided into direct and indirect based on men's age-specific pro rata shares of these two types of work. For the few countries with parts of their UCW system where a total work gender gap is in

women's favor, women's UCW time increases to eliminate the gap.)

- **Women decrease UCW to reduce market work gap with men.** What if women's time spent in market labor increases over the next fifty years to close the gender gap in market work with men by half, but at the same time, women decrease their UCW production by the same number of hours so that their total work amount does not change? As in the "men increase UCW"scenario, there is still gender specialization, but it is less over time. Gender gaps in total work do not change in this scenario.

The results of these scenarios are evaluated by comparing the care support ratios they create in 2065 relative to 2065 ratios for the baseline scenario (the UCW system of the age profiles does not change). The purpose of these alternative scenarios is not to imagine that any one of them is more or less likely to occur, but to understand the magnitude of different types of change.

The results are shown in Table 3. The baseline scenarios as in Figure 11 are given just for the final year 2065 in the first set of columns. Moving to the right shows results for the first alternative scenario, "QQ Tradeoff."The 2065 values appear in the upper block of rows and the difference between baseline 2065 and the alternative 2065 appear in the lower block of rows. The

basic idea of the QQ Tradeoff alternative scenario was that the age- and sex-specific consumption patterns of direct care would increase relative to the supply, no matter how that supply changed, so the direct care support ratios are all one here. What this means for the overall support ratios, however, is that there is no decreased demand for childcare due to population aging and thus the strong increases in care support ratios seen in the baseline scenario are either attenuated or changed into decreases. Given that we have empirical evidence that such a QQ Tradeoff is plausible, it is right tobe cautious about lower fertility easing overall childcare burdens. However, even in the face of the challenge this may mean to provide care, the QQ Tradeoff scenario could still be welfare improving if it means greater investments in the care of children and ultimately more productive humans.

The next alternative scenario in the columns to the right is the "Men Increase UCW." This scenario only considers increases in UCW production, so the care support ratios increase for all countries and types of UCW. The scenario increases men's share of the UCW system only to the extent necessary to close any gender gaps in total work, though, so we see large increases in care support ratios in this scenario for countries with large gender gaps in total work, such as Mongolia and Senegal. For Bangladesh, Germany, and the United States, on the other hand, there is not much gap in total work to close.

〈Table 1-3〉 Projected care support ratios in 2065 by scenario, and the difference between alternative scenarios and baseline

Scenario:	Baseline			QQ Tradeoff			Men Increase UCW			Women Decrease UCW		
	Total	Indirect	Direct	Total	Indirect	Direct	Total	Indirect	Direct	Total	Indirect	Direct
Projected Support Ratios in 2065 relative to 2015:												
Bangladesh, 2012	1.13	1.10	1.47	1.09	1.10	1.00	1.15	1.12	1.48	0.79	0.78	1.00
Colombia, 2012	1.05	1.04	1.06	1.02	1.04	1.00	1.18	1.13	1.23	0.92	0.89	0.95
Costa Rica, 2013	1.04	1.05	0.98	1.05	1.05	1.00	1.19	1.20	1.14	0.84	0.85	0.81
Germany, 2002	0.95	0.96	0.88	0.96	0.96	1.00	1.00	1.01	0.91	0.88	0.90	0.79
Ghana, 2009	1.16	1.05	1.56	1.03	1.05	1.00	1.42	1.25	1.98	0.95	0.85	1.31
India, 1999	1.02	0.98	1.42	0.98	0.98	1.00	1.13	1.06	1.70	0.65	0.61	0.97
Italy, 2002	0.93	0.94	0.85	0.95	0.94	1.00	1.11	1.12	1.03	0.82	0.84	0.72
Mauritius, 2003	0.97	0.97	0.96	0.98	0.97	1.00	1.07	1.08	1.07	0.81	0.81	0.79
Mexico, 2014	1.10	1.06	1.30	1.04	1.06	1.00	1.17	1.12	1.43	0.87	0.83	1.05
Mongolia, 2015	1.10	1.03	1.47	1.02	1.03	1.00	1.44	1.32	2.06	1.05	0.98	1.39
Senegal, 2011	1.19	1.05	1.41	1.03	1.05	1.00	1.54	1.42	1.72	0.92	0.82	1.07
South Africa, 2010	1.07	1.04	1.36	1.04	1.04	1.00	1.19	1.17	1.47	0.92	0.90	1.14
Spain, 2009	0.94	0.96	0.85	0.96	0.96	1.00	1.13	1.15	1.03	0.89	0.91	0.80
Thailand, 2014	1.01	0.98	1.17	0.98	0.98	1.00	1.17	1.12	1.39	0.85	0.83	1.00
Turkey, 2014	1.04	1.00	1.32	1.00	1.00	1.00	1.18	1.14	1.48	0.85	0.82	1.03
United States, 2009	1.00	1.00	1.02	1.00	1.00	1.00	1.06	1.06	1.08	0.93	0.93	0.93
Uruguay, 2013	1.04	1.02	1.12	1.01	1.02	1.00	1.21	1.17	1.33	0.92	0.90	0.99
Vietnam, 2015	1.00	1.00	1.01	1.00	1.00	1.00	1.09	1.10	1.09	0.97	0.97	0.97
Differences relative to baseline projection:												
Bangladesh, 2012				-0.04	0.00	-0.47	0.02	0.02	0.01	-0.34	-0.33	-0.47
Colombia, 2012				-0.03	0.00	-0.06	0.13	0.09	0.17	-0.13	-0.15	-0.11
Costa Rica, 2013				0.00	0.00	0.02	0.15	0.15	0.17	-0.20	-0.20	-0.16
Germany, 2002				0.01	0.00	0.12	0.05	0.05	0.04	-0.07	-0.06	-0.09
Ghana, 2009				-0.13	0.00	-0.56	0.25	0.20	0.42	-0.21	-0.20	-0.25
India, 1999				-0.04	0.00	-0.42	0.11	0.09	0.28	-0.37	-0.36	-0.45
Italy, 2002				0.02	0.00	0.15	0.18	0.18	0.17	-0.11	-0.10	-0.13
Mauritius, 2003				0.01	0.00	0.04	0.10	0.10	0.11	-0.16	-0.16	-0.17
Mexico, 2014				-0.05	0.00	-0.30	0.08	0.06	0.13	-0.23	-0.23	-0.25
Mongolia, 2015				-0.08	0.00	-0.47	0.34	0.29	0.60	-0.05	-0.05	-0.08
Senegal, 2011				-0.17	0.00	-0.41	0.35	0.37	0.30	-0.27	-0.23	-0.34
South Africa, 2010				-0.03	0.00	-0.36	0.12	0.12	0.11	-0.15	-0.14	-0.21
Spain, 2009				0.03	0.00	0.15	0.19	0.19	0.18	-0.05	-0.05	-0.05
Thailand, 2014				-0.03	0.00	-0.17	0.16	0.15	0.21	-0.15	-0.15	-0.17
Turkey, 2014				-0.04	0.00	-0.32	0.14	0.13	0.16	-0.20	-0.19	-0.28
United States, 2009				0.00	0.00	-0.02	0.06	0.06	0.07	-0.07	-0.07	-0.08
Uruguay, 2013				-0.03	0.00	-0.12	0.17	0.16	0.21	-0.12	-0.11	-0.13
Vietnam, 2015				0.00	0.00	-0.01	0.09	0.10	0.08	-0.04	-0.04	-0.03
			Average:	-0.03	0.00	-0.18	0.15	0.14	0.19	-0.16	-0.16	-0.19

Finally, we have a scenario in which gender gaps in market work close by half by 2065. For some countries still experiencing steady increases in female market labor force participation, this is realistic. For others where those increases have stalled, it is less so. The impact on care support ratios in this scenario

comes from the idea that, in order not to exacerbate gender gaps in total work, women decrease their UCW time in exactly the amount that they increase their market work time. In the results for this scenario, most countries' total UCW support ratios fall by the end of the projection period. This is an important result in the context of many countries'hopes that women's increased market labor force participation will buoy overall population productivity in the face of population aging. Without other policy interventions, then, more market labor for women means either greater potential time poverty for women who increase their total work, or potential problems meeting the demand for care.

4. Care support ratios compared to economic support ratios

The final set of results compares traditional economic support ratio (ESR) indicators of market demographic dividends with care support ratios (CSR) that estimate the demographic dividends that might accrue from future changes in age structure affecting the care economy. Figure 12 shows the same total care support ratios as shown in Figure 12 (the black lines), but now also includes economic support ratios (green dashed lines). As in Figure 11, the paths are all calibrated to equal one in 2015 and then change based on projected demographic change until 2065.

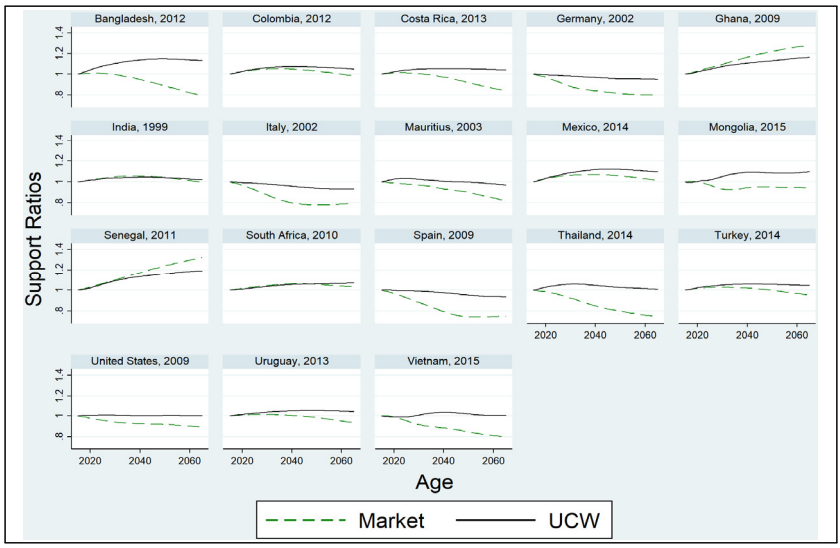
Ghana and Senegal are the only countries with increases in the ESR greater than those available in the care economy, and even for these two countries the CSR is still large. In countries like Bangladesh, Germany, Italy, Spain, Thailand, and Vietnam, where population aging is expected to present challenges to the market economy, the CSR shows a much rosier picture. What does this mean for policy? It means that time dynamics in the unpaid care economy may be able to ease some of the strains in the market economy. It also means that in the near future, the challenge of population aging will no longer be just a rich country phenomenon. Lower- and middle-income countries will end their demographic dividend phase when those green dashed lines start to fall. What we see in many of the CSRs in those economies is that attention paid to unpaid care work could help extend the dividend phase a little longer and help these countries get richer as they get older.

How could this happen? Unpaid caregivers could take the time "freed up" by relatively lower demands for unpaid care work and shift that work to the market economy. If some of the freed up time came from reducing time spent in low-productivity activities like gathering water or fuel, or household drudgerythat would enhance overall population productivity. However, in the previous analysis showing care support ratios for direct versus indirect care, we saw that most of these gains represent time freed up in direct childcare. Productivity there

is hard to quantify, but probably safe to say that it is higher productivity than sweeping floors. Given evidence that parents tend to reinvest the freed up time in more intensive childcare for fewer children, this could still produce a benefit in the future, but it would be delayed by a generation while the children who received potentially productivity-enhancing investments made their way into the labor market.

If policymakers sought a transition of this free time into market work, however, they would likely need coordinated policies that made mothers feel welcome in the labor force. That means opening all fields of employment to women and dismantling social and institutional barriers to women entering traditionally male dominated occupations. It means high quality public education and daycare available for their children, and a social environment accepting of mothers combining work and family. It also means a work world that does not pretend workers have no obligations outside of paid employment, but rather supports them with flexible family leave policy, good quality decent jobs, and work schedules that are conducive to family life.

[Figure 5-12] Projected total unpaid care support ratios and economic support ratios, 2015 - 2065



Discussion

Using time use data and an attention to patterns by age and sex, this work has revealed how much productive capacity goes into unpaid care work, mostly by women. This work is vital to society now and in the future. Combining the focus on unpaid care workwith data on market work as well demonstrates that we live in gendered economies, with men and women and girls and boys leading different lives. This gendered system, being so universal across countries, likely originated in our past population regime ofhigh fertility necessitated by the very high

mortality of children and childbearing women. Those conditions no longer hold, and we see evidence of this system changing all over the world, exemplified by the global diversity in the degree to which gendered economies still prevail. These cultural institutions can be very entrenched, however, continuing to shape lives long after the conditions that gave rise to them have changed completely. Our purpose here was to reveal the diversity in the gendered economy across countries and did not include any attempt to understand how the diversity in gendered economies across the 18 countries might be explained by other factors. Future work can consider how the patterns observed vary by income level, region, cultural ideas on gender roles, and how the paid labor market functions in each country.

Demographic dividend analysis, long focused on how population changes affect our market economy, tells only half the story when it ignores the closer links between population changes and family formation and change. Demographic change is just as salient inside the household in our unpaid work lives as it is inside a firm where we are paid. The most important point here, though, is that policies to take advantage of unpaid care work demographic dividends must be much more gender-aware and family-aware than is usually the case. Specifically, the usual demographic dividend policy emphases are on family planning and reproductive health, education and

health investments, and good governance policies to make countries desirable destinations for foreign direct investment. The policies that will allow the realization of dividends from changes in the UCW economy are targeted gender equity and social change policies: removing legal and cultural barriers to women's full participation in market work, enhancing the cultural acceptability and expectations around men's participation in UCW, and labor market policies which make the combining of market work and UCW easier.

There are, of course, some large unknowns in the analysis and major areas that call out for better data and new thinking on methods. The health of elders will be an important part of our aging future, as will the ability of our labor markets to create good jobs. More comparable time use data in more countries is necessary to truly understand how our unpaid care work economies function, and better methods to measure eldercare will help us avoid an avalanche of unforeseen demand for eldercare. Finally, in terms of this particular analysis, future work will focus on a way to tie the market and household sectors together to create overall demographic dividend analyses that include dynamics between market labor and unpaid care work, and between paid and unpaid care work as well.

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VI

Political Sustainability of Public Intergenerational Transfers

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Abstract

Public intergenerational transfers may arise because of the failure of private arrangements to provide optimal economic resources for the young and the old. We examine the political viability of the system of public intergenerational transfers – both forward to the young (i.e. education) and backward to the elderly (i.e. pensions) -- by asking what the outcome would be if the decision per se to reallocate economic resources between generations was put to the vote. For this, we test Rangel's (2003) theoretical prediction on political economy of intergenerational transfers exploding the specific structure of the National Transfer Accounts data. This data allows us to consider both forward and backward intergenerational transfers. The results show that future population aging would reinforce political support and strengthen political viability of a joint sys-

tem of public transfers for pensions and education. More specifically, our findings indicate that countries with a developed system of public intergenerational transfers (i.e. a big welfare state) and "greying" population structure would vote in favor of a joint system of pensions and education if such a vote would take place. In contrast, countries with relatively young populations where public intergenerational transfers are still dominated by private arrangements would vote down such a system as they have less political incentives to support it.

JEL Codes: D70, H50, J10, P16.

Keywords: Public Intergenerational Transfers, Population Aging, Political Economy, National Transfer Accounts.

Introduction

The past century has been characterized by dramatic changes in the western world that have impacted many dimensions of human societies. From an economic perspective, the extension of markets, globalization, and technological progress have been the primary drivers of economic development. In parallel with these changes, is the steady improvement in life expectancy coupled with a decline in birth rates, which has altered the age structure of the population in a slow but notably irre-

versible fashion. At some point in this process, democratization emerged, leading to the expansion of public education –a key element in the overall process – and other social policies, thus creating what we know nowadays as the welfare state.

These three axes of socio-political development are closely connected, although they evolved at different paces. The driving force and the direction of changes is not clear. However, there seems to be a common element in each of these processes: namely, the changes in family structures that have taken place over the last hundred years. Indeed, the improvement in economic conditions has affected family structure and, in turn, demography: first, by decreasing the share of agriculture in production, structural changes pushed families to reside in the cities, affecting intergenerational living arrangements; second, by the economic development that is clearly a driving factor of increased life expectancy. Fertility is also affected by economic growth. On the one hand, technological change increases the returns to education and hence increases the cost of educating children. This also affects female employment: women eventually offer their labor force on the market leading to a fall in fertility rates (the so-called opportunity cost of children increases). On the other hand, fertility control lets households make choices about number and timing of offspring. As said above, this process was fostered by the extension of education, which eventually became public and compulsory, while laws

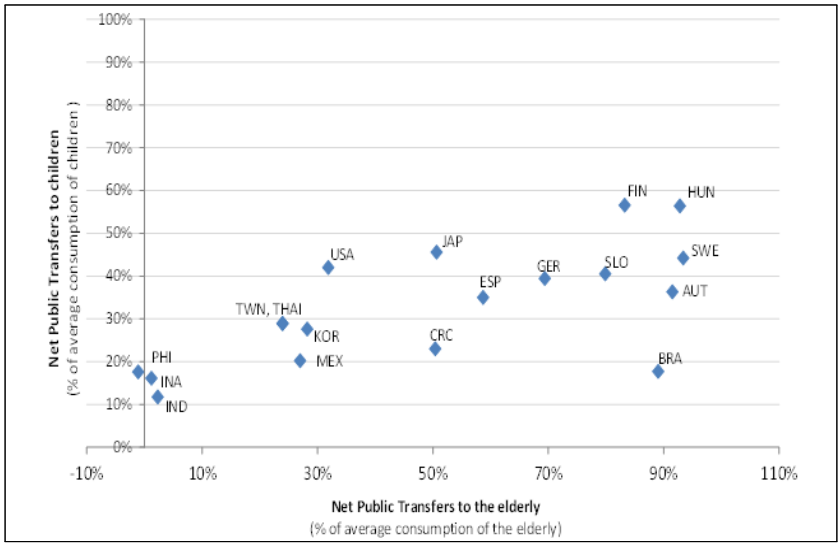
regulating child labor were enacted. Female rights also gradually improved and a public pension and healthcare system was introduced in many countries. As a result, to a very large extent, the welfare state replaced intergenerational family transfers. Family monetary and time transfers have been dramatically modified and some of them are now provided by the market.

The welfare impact of those changes is at the frontier of Economics, Demographics and Political Science. Specialization and the lack of data limited research in the past. The National Transfer Accounts (NTA) project contributes to fill this gap by stablishing a comprehensive measure of the age reallocations occurring among the different age groups by means of the market, the family and the government. Interestingly, a quite surprising result has been reached so far: As long as it develops, the welfare state tends to favor the old at the expense of the young, despite the fact that in the case of children it is less likely to recur to the market. Therefore, the welfare state transfers are substituting family transfers, but in an asymmetric or biased way.

Figure 1 shows the share of consumption financed bypublic transfers (net of taxes) for children and the elderly. Most countries, especially those having a sizable welfare state, go beyond 50% in case of the elderly, while almost all of them are below 50% for children. This means that families — through private transfers —bear the cost of child rearing, which is usually aug-

mented by a considerable time cost; despite the fact that in the case of children it is less likely to recur to the market.

[Figure 6-1] Asymmetric distribution of public resources between young and elderly



Source: reproduced from Solé et al. (2020).

In the current study, we investigate the political viability of such a system. More specifically, our main contribution is to empirically examine the political sustainability of the public system of backward (from parents to children) and forward (from adults to the elderly) public intergenerational transfers (hereafter, FITs and BITs, respectively). We achieve this by determining a particular voting outcome when the decision to reallocate economic resources per se is put to the vote. For this

purpose, we conduct an empirical exercise based on the political economy application derived by Rangel (2003). This application considers a realistic demographic structure, where agents live in the first two decades as children, in the next five as working age adults and in the last two as retirees. All the decisions regarding the size and the directions of public transfers are made through a majority rule. In this context, certain conditions under whichit is possible to have a politically sustainable system of intergenerational transfers must be satisfied. More specifically, the majority of the voting cohorts must have a positive continuation value –which is a present value of all benefits received minus taxes paid – for the joint system of BITs and FITs.

In order to calculate the continuation values we exploit the data from the National Transfer Accounts (NTA project) which provides us with detailed accounting of the direction and the magnitude of public intergenerational transfers for each age group coherent with National Accounts. This particular nature of the data enables us to calculate the continuation value for every voting cohort of the countries included in our sample in order to assess the political support for public pensions and public education if such a vote would take place.

Our findings indicate that countries with a developed system of public intergenerational transfers (i.e. a big welfare state) and "greying" population structure would vote in favor of a joint

system of BITs and FITs if such a vote would take place. In contrast, countries with relatively young populations where public intergenerational transfers are still dominated by private arrangements would vote down such a system asthey have less political incentives to support it. In line with the theoretical predictions derived in Rangel (2003) we show that future population aging would reinforce political support and strengthen political viability of a joint system of public transfers.

The remainder of the paper proceeds as follows. In Section 2, we provide a literature review on the political economy of intergenerational transfers and population aging. Section 3 presents the data and the methodology. In section 4, we provide the results of our empirical exercise on pensions and education as well as on total public intergenerational transfers (IGTs). The last section contains final remarks and some insights on what we learn from this exercise, the potential policy implications and future direction of research.

Literature Review

The literature on public IGTs is large but fragmented. It dates back to initial studies that sought to determine the golden rule of capital accumulation in the standard overlapping- generations (OLG) framework (Diamond,1965). In this setting, ab-

stracting from altruism and the consideration of young dependents, the failure of the competitive economy to meet the golden rule creates a key role for public IGTs financed via capitalization (pay-as-you-go) when there is under (over) accumulation.

After some decades, and probably as a result of the demographic transition, the literature on intergenerational transfers struck out again but in a number of different directions. Some authors highlight the fact that besides the elderly, children are also dependent. Peters (1995) and Boldrin and Montes (2005) investigate policy when parents take decisions regarding their children's human capital, while Bental (1989) and Abio et al. (2004) consider fertility to be endogenous. Once accounting for the dependence of both age groups, the need for government intervention might derive from the fact that the markets and intra-family reallocations are failing to achieve certain important social goals by providing low investments for the young (forward transfers, i.e. education) and pensions for the old (backward transfers, i.e. pensions) (Becker and Murphy,1988). One way of solving this problem is to create a social contract that links public education and pensions and provide generations with appropriate incentives to reallocate public funds to each other.

Thus, the connection between the transfers to children and the transfers to the elderly has emerged also in the public sphere. Pogue and Sgontz (1977) and Konrad (1995) argue that

the design of the pay-as-you-go (PAYG) pension system creates the appropriate incentives to invest in public education, because it enhances the income of the future working generation. Following their argument, the working-age generation is only willing to pay "today" for public education if it has gains in terms of higher productivity "tomorrow". According to Boldrin (1992) and Boldrin and Rustichini (2000), another incentive for the working-age generation to transfer economic resources towards the young could be the higher returns on savings. More specifically, the decision to invest in education reflects positively on physical capital productivity because of its complementarity with human capital productivity. This in turn enhances the future return on savings and therefore offers higher future income to the current workers.

Another theoretical study by Kemnitz (2000) considers the link between pensions and education in an OLG setting using the public choice framework, where policy is forged by the relative political power of generations. The level of IGTs is decided by the majority of voters in a context of representative democracy, where governments seek to maximize political support. The main result stemming from this study is that the structure of the PAYG pension system stimulates investments in education that provide future benefits for the current working generation. According to this study, the structure of the PAYG pension system provides incentives to the working-age gen-

eration to support educational transfers towards the young even in the absence of altruism.

However, the demographic transition is expected to have a significant impact on the aforementioned intergenerational link between pensions and education. According to the median voter theorem, governments implement the distribution of public funds that is preferred by the median voter (Downs 1957) and as the median voter becomes older – due to population aging –the political clout of the elderly seems set to grow. In turn, the increasing political power of the elderly transforms the allocation of public resources, shifting more resources towards the older cohorts (e.g. for pensions) and fewer to the younger cohorts (e.g. for education) (Browning 1975). In the context of a limited fiscal budget, this reallocation of public funds might trigger a "struggle" for fiscal resources between the young and elderly, the so-called "intergenerational conflict" hypothesis.

Despite this, a number of theoretical studies show that a positive link between public pensions and education is actually strengthened as population ages (Kemnitz, 2000; Gradstein and Kaganovich, 2004). The idea developed in Gradstein and Kaganovich (2004) is that population aging has two opposite effects on public education spending: on the one hand, the direct effect of the aforementioned "intergenerational conflict"; and, on the other, the fact that there are working-age agents who foresee that they are going to live longer because of the

increase in longevity. These agents also realize that the increased number of retirees makes the PAYG pension system less generous in terms of spending per retiree. Having anticipated these outcomes, they react by investing more in education in the current period in order to take advantage of the future higher productivity of these young people (i.e. an indirect effect). In this way, working-age agents pursue an increase in future tax revenues and endeavor to ensure a higher return on their savings in order to deal with the increased fiscal needs of a prolonged retirement. The authors derive theoretically that even in the absence of altruistic linkages, the indirect effect is stronger than the direct and that, therefore, the aging process might have a positive impact on the education spending.

In Michailidis et al. (2019) using panel data from OECD countries we investigate whether or not population aging can reinforce investment in education in a system where generations are connected through the PAYG pension scheme. Our main results indicate that the current population aging has a negative effect on education that is conditioned on the level of pension spending (direct effect dominates indirect). However, when we consider the projected population aging we observe a positive effect on education spending driven by the reaction of working-age agents to the forthcoming changes in the intergenerational transfers (indirect effect dominates direct). The latter result can indicate that in a joint system of public pen-

sions and education where generations are connected through a PAYG pension scheme, the intergenerational link plays a crucial role for the anticipation of the future population aging. In such a setting, the projected population aging can boost the investment in public education in order to increase the financial sustainability of a public system of pensions and education.

From the perspective of Political Economy, another important aspect of a joint system of intergenerational transfers like pensions and education is its political sustainabilitygiven the life cycle dimension of those policies. Thus an important question arises here: Can such a system be politically sustained? From the perspective afforded by Political Economy, a critical aspect of such a system is its political sustainability and the actuarial fairness between contributions paid and benefits received.*Hence, it is of a great interest to investigate the political viability of a joint system of backward (i.e. public pensions) and forward (i.e. education) intergenerational transfers by seeking to determine the political outcome if the decision to reallocate economic resources per se was put to the vote. In the literature of Political Economy, such an attempt to gauge the political support provided to a system of linked pensions

* Regarding the actuarial fairness, Bommier et al. (2010) calculate present values of generations before the introduction of public intergenerational transfers and for a long period after. They try to assess whether the generations have been benefited from the public transfers or not. The results suggest that most generations born after 1930 have been better off from the introduction of social security and public education.

and education can be found in the theoretical study of Rangel (2003).

In his paper, by employing a game theoretical framework of intergenerational exchange, Rangel examines the possibility of sustaining a system of public forward and backward intergenerational transfers (FITs and BITs, respectively). He uses the concept of a sub-game perfect equilibrium in order to investigate, in the context of selfish generations, the ability of non-market intergenerational arrangements to invest optimally in forward and backward transfers. According to Rangel, for this to happen three conditions must be satisfied. First, the agents should have at least two exchangeproblems that require simultaneous cooperation. Second, the intergenerational program must generate a positive continuation surplus in order to be supported by the middle-aged generation. And, third, the generations must play a game of simple trigger strategies that creates the link between BITs and FITs. The fear of punishment provides incentives to the middle-aged generation to choose the right amount to invest in BITs and FITs.

Data & Methodology

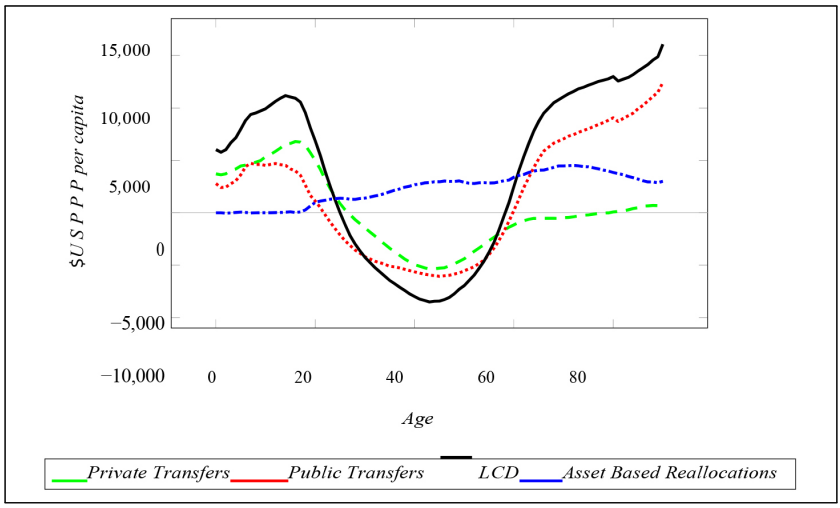
1. National Transfer Accounts (NTA) Data

The biological fact that people are physically dependent on others, especially during childhood and old age has been tackled in a variety of ways. Traditionally, these dependency needs have been addressed within the family via private transfers. However, the welfare state has gradually extended its action from mere monetary transfers for poverty reduction to broader welfare programs, including the provision of basic social goods (education and health), and to income substitution programs, including pensions, with a high insurance component. Interestingly, this process has led to the gradual substitution of private intergenerational transfers from the public sphere.

Conventional National Accounts do not permit to analyze the way people behave at different stages of the economic life cycle. More specifically, such methods usually report annual flows of public benefits and taxes as a share of GDP. Although this is useful information, it does not capture the age direction of public transfers and, therefore, fails to provide information about who pays and who receives, being crucial when demographic structure is changing. By way of alternative, here we exploit the specific structure of the National Transfer Accounts (NTA) data, which provide us with a complete, systematic and

coherent accounting of economic flows from one age group to another. The NTA data is taken from Lee and Mason (2011)*.

[Figure 6-2] Life cycle deficit and intergenerational transfers



Notes: Average Lifecycle deficit (LCD) and public (TG) and private (TF) transfers for 18 countries. The higher the LCD, the greater is the need for intergenerational transfers. Values are calculated by converting currencies to US dollars (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country. See detailed country graphs in the Appendix, Figure A.1.
Source: Authors' elaboration using NTA data (www.nta.org)

Starting from the national accounting identity, this method employs public administrative data and micro data surveys to measure, first, the age reallocations made by the public sector, and, second, the private transfers within the family. Figure 2 plots the average age profile of the life-cycle deficit (LCD) for

* http://www.ntaccounts.org/web/nta/show/Country%20Summaries. The NTA manual presents the concepts, methods and estimation procedures to measure these flows over the life cycle (UN, 2013).

eighteen countries and how this is financed via private (TF) and public transfers (TG). The part of LCD not covered by transfers is funded resorting to the asset market (asset income and dissaving). These NTA age profiles are consistently upgraded in the National Accounts. The transfer profiles (TG and TF) are net of taxes.*

These NTA estimates provide us with measures of total public transfer inflows (benefits) and outflows (taxes and public asset-based flows) by single years of age.** We use cross- sectional data for a specific year in each of 18 countries.*** Likewise, when available, we use the same type of public transfer data disaggregated between pensions and education.**** These data provide us with the net transfers (net of taxes and/or contributions) received by individuals at each stage of the life cycle, thus enabling us to gauge their willingness to vote. In this way, we are able to assess the political sustainability of the IGT system, i.e. of pensions and education.

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* In the case of public transfers, the NTA method assigns an aggregate amount of taxes to each category of public expenditure using the age profile of explicit earmarked taxes, that is, social contributions, in the case of pensions, or general taxes in all other cases. The balance is set to zero and the eventual surplus/deficit is recorded as public savings/dissaving.

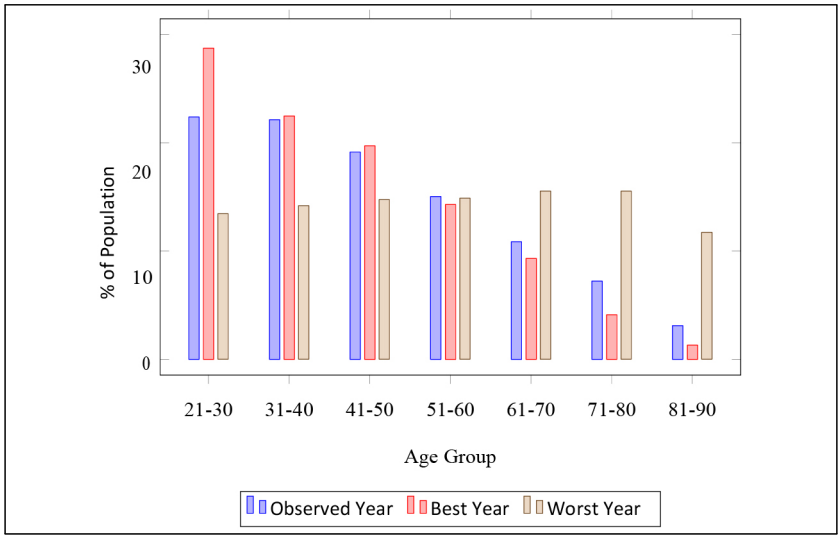
** Public transfers comprise public education, health, pensions, and other in-kind and in-cash transfers. Each of these categories includes the inflows and outflows that people receive and pay during each year of their life.

*** Austria (2000), Brazil (1996), Costa Rica (2004), Finland (2004), Germany (2003), Hungary (2005), India (2004), Indonesia (2005), Japan (2004), Mexico (2004), Philippines (1999), Slovenia (2004), S. Korea (2000), Spain (2000), Sweden (2003), Taiwan (1998), Thailand (2004), US (2003).

**** Such data are not available for either Indonesia or the Philippines.

Moreover, we use data for the current demographic structure of each country as well as for that projected in the future to compute the size of the voting cohorts.

[Figure 6-3] Demographic structure of population per cohort (on average)



Notes: Observation year is the year that each country in the sample is observed. The "best" and the "worst" years are identified using the old-age dependency ratio. Hence the "best" ("worst") year is the year with the lowest (highest) old-age dependency ratio. As can be seen, population aging has a substantial impact on the demographic structure of the voting cohorts. Details on the demographic structure of each country are provided in Figure A.2, in the Appendix.
Source: Authors' elaboration using NTA data (www.nta.org)

Figure 3 illustrates the demographic transition showing the current population age structure compared to the "best" and "worst" years defined in terms of old-age dependency. The old-age dependency ratio is the percentage of people over 65 in the working age population (15-64). Hence the "best"

("worst") year is the year with the lowest (highest) old-age dependency ratio. Finally, we use data on the real interest rate, drawn from the World Bank database.*

2. Methodology

The empirical exercise that we conduct in this section is based on the political economy application proposed by Rangel (2003). In his stylized model, individuals of different generations interact to decide on the size of IGTs. Intergenerational altruism does not exist, so every decision is driven by selfish preferences. Rangel argues that it is possible to have a sustained IGT system with positive BITs and FITs even with "egoistic" generations. As discussed in the previous Section, for this to happen, three conditions must be satisfied. First, agents should have at least two exchange problems that require simultaneous cooperation. Second, the intergenerational program must generate a positive continuation value for working cohorts for them to back it. Third, each generation should be engaged in a game of simple trigger strategies, where the fear of punishment creates a link between FITs and BITs, i.e., an incentive for the middle aged to invest sufficiently in transfers to the old and young to avoid the punishment for not cooperating.

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* Data taken from the World Bank (see, http://data.worldbank.org/indicator/FR.INR.RINR). The real interest rate is defined as the lending interest rate adjusted for inflation measured by the GDP deflator.

By way of application, Rangel generates a political economy model where agents live for nine periods and where each period represents ten years. We adapt the application of Rangel (2003) to more realistic circumstances where agents live 90 periods (a = 1, ..., 90) and where each period represents a year. Individuals are dependent children during the first 20 years, working age adults until the age of 65 and retirees for the rest of their life until they reach age 90. Only workers receive an income, while the rest only receive transfers. Agents can borrow and save at the interest rate r, (r>0). In addition, every period, society decides the amount it wishes to devote to the system of BITs (i.e. public pensions, health care, other in-cash or other in-kind transfers). The system is financed solely by workers, who have to pay a lump-sum payroll tax, T.[9] Finally, there is another lump-sum tax, E, used to finance the FITs (i.e. education, child health care, other in-cash or other in-kind transfers), which is imposed on both workers and retirees.

In the following section, we explain in detail how we adapt the aforementioned application to our data to compute the continuation value of the system of IGTs to assess the political viability of such a system.

1) Continuation Value

The continuation value or surplus is the value generated from the transition from a state of autarky to one in which IGTs take

place. The continuation value of the BITs is measured as the present value of all benefits received minus taxes paid.*

In the case of the linked system of pensions and education (Section 4.1), all the benefits received by the voting cohorts are those received during the retirement period (a ≥ 65); and, all the taxes paid are those paid during the working age period (a = 20...64). The continuation value is computed as shown by equations 1 and 2 following the stylized model of Rangel (2003) which we adapt for more periods (90 instead of 9 periods).

In the case of total public transfers (Section 4.2), we consider taxes (benefits) paid (received) by the voting age groups -both workers and pensioners (a ≥ 20) in order to calculate the continuation value of total public IGTs. In this case, we take into account the present values ofall the benefits received less the taxes paid during working age and retirement as shown in equation 3.**

$$CV_a = \sum_{i=65}^{90} \frac{PB_i}{(1+r)^{i-a}} - \sum_{i=a}^{64} \frac{PT_i}{(1+r)^{i-a}} \qquad (1)$$

where CV_a is the continuation value for working age population

* We assume a constant productivity growth rate (an annual 1.5%) to transform cross-sectional NTA age profiles into the foreseen longitudinal profiles.

** This is the baseline version; in the case of the total public transfers below, we also take into account the non- payrolltaxes that the elderly pay and the benefits that the working-age agents receive in order to compute their continuation value. This equation is authors' elaboration on the basis of present value analysis.

($a \geq 20$), PT are the payroll taxes paid by workers $a \geq 20$ and PB are pension benefits received when retired a = 65...90, and

$$CV_a = \sum_{i=65}^{90} \frac{PB_i}{(1+r)^{i-a}} \tag{2}$$

where CV_a is the continuation value for the retirees a = 65...90.

$$CV_a = \sum_{i=65}^{90} \frac{PB_i}{(1+r)^{i-a}} \frac{TPB_i - TT_i}{(1+r)^{i-a}} \tag{3}$$

where TPB are total public benefits and TT are total taxes paid by cohorts aged 20 and more ($a \geq 20$) for public IGTs.

2) Voting

The continuation value measures the value of keeping the current system (i.e. public pensions or total public transfers towards the adults) and, hence, the willingness to vote in favor of it. Furthermore, according to Rangel's model, only if the continuation value is positive for the majority of voters it is possible to invest in education. In each period, voters choose between (0; T) for the BITs and between (0; E) for the FITs. All agents in cohorts a= 20...90 cast a vote. This means that if we have a representative voter for each cohort (year), there are 71 voting cohorts.*

First, what is needed for a viable BITs (i.e. PAYG pension) system is to hold a majority, that is, to obtain at least 36 votes in favor of such a system. Bearing in mind that retirees always vote in favor of the current system – because they receive positive net transfers –the decision to retain the current system depends entirely on the middle-aged cohorts. More specifically, cohorts a = 20...64 are the final decision makers. That is, to sustain the system in a representative voting scenario, at least 10 out of these 45 votes are needed to ensure a simple majority. This means that as long as the continuation values of at least 10 out of 45 middle-aged cohorts are positive, the majority votes for BITs (i.e. pensions). Note that the middle-aged cohorts vote for BITs not because they care about current retirees, but because they believe, quite rightly, that otherwise they will be "punished" by the young generation and will not receive any benefits when retired.

However, to sustain a system of bilateral intergenerational transfers (BITs and FITs) besides choosing the amount deemed sufficient to invest in BITs, it is also needed to invest optimally in FITs.* Thus, if Equation (4) holds for, at least, 35 of the age

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* In more realistic case, as shown below, we weightthe votes by the size of each cohort using the demographic structure as a proxy for the electorate size of each cohort.

* This is a direct consequence of generations adopting simple trigger strategies. In fear of being punished and receiving no benefits, current working cohorts are forced to transfer and invest optimal (sufficient) amounts in BITs and FITs, respectively.

cohorts a = 20...89, the majority is willing to vote for education, because the system – that links BITs and FITs – generates a continuation value that is bigger than the FITs (i.e. education) tax that they have to pay.*

$$CV_a = EP_a \tag{4}$$

where P_a is the relative size of each age cohort and E the tax to finance education. In short, there could be a sustained path of BITs and FITs –and hence a system of IGTs would be politically viable –if three conditions are satisfied. First, if and only if, the continuation value of choosing BITs is positive for the majority of voters (Equations 1, 2 or 3). Second, if and only, if the continuation value of BITs is greater than the amount invested in FITs (Equation 4). And third, if age cohorts play voting strategies that link BITs to FITs.

The next section shows the results, which we expect to be driven bythe age shape of the public transfers profile plus the demographic structure of each country. In addition, the usual discount effect should also be noted, that is, where taxes paid and benefits received at earlier stages in the life cycle are discounted to a lesser extent.

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* Note that cohort 90 always votes against FITs because they are not alive during the next period. The amount invested in FITs is paid proportionally in accordance with the size of each cohort.

Results

This Section is devoted to present the results of our simulation exercise aimed to evaluate the political sustainability of public transfers programs. First, following Michailidis and Patxot (2019), Section 4.1 shows the results restricting the analysis to pensions and education. Next, Section 4.2 extend the study to the whole system of BITs and FIGs.*

1. Pensions and Education

Pensions and education have been linked in the previous literature and are the main public policies specifically devoted to the two dependent sides of the economic life cycle (i.e. children and the elderly).**

First, we compute the continuation values for the pension systems in our sample of countries. Second, by deducting tax E to finance education, we obtain the continuation value for the system of pensions and education. Finally, we assess whether

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* See also Michailidis and Patxot (2018) for an extended version. The results are qualitatively the same, but differ to some extent because in this version, the discounting process is refined and productivity growth rate is used to transform the cross-sectional NTA profiles into the foreseen longitudinal profiles foreseen by agents.

** The size of public pensions and education in OECD countries in 2013 was on average 8.2% and 4.8% of GDP, respectively. Data on public pensions and education are taken from OECD (https://data.oecd.org/socialexp/pension-spending.htm and https://data.oecd.org/eduresource/public-spending-on-education.htm, respectively.

such a system is viable during a particular year for each sample country, and also when using alternative demographic scenarios.*

First, using equations 1, 2 and the real interest rate -for each country in a particular year- we calculate the continuation value of pensions for each voting age cohort. As can be seen from Table 1, the continuation values that we obtain are negative for the relatively young cohorts (up to 40 years old) for the vast majority of the selected countries.** The results confirm the aforementioned theoretical predictions made by Rangel (2003). The interpretation is quite straightforward. Under dynamic efficiency, young workers aged (20 to 40) are unwilling to support the system of pensions (or a system of IGTs in general), because given the present values the taxes they pay are higher than the benefits they would potentially receive. At the same time, it is clear that retirees (65 to 90 years old) fully support the system, because they enjoy retirement benefits without having to pay any additional taxes or contributions. With young voting cohorts being against and retirees in favor of the system, the final outcome of the voting procedure depends on age groups between 41 and 64 years old. As it is derived from the results of Table 1, the CVs of groups 50 and above are positive for all countries except Brazil, Costa Rica, South Korea, Taiwan and Thailand.

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* Data for Indonesia and the Philippines are not available for this section.

** This result is in line with Bohn (1999), who calculates the continuation value of PAYG social security in the US. He shows that it is negative for the young voters, but strictly positive for voters above the median voter age.

Next, we use the continuation values in order to gauge what would be the support the electorate for pensions if this decision was put to the vote. As Table 2 shows, the vast majority of countries (13 out of 16 countries – see column 2) obtain support for pensions (above 50%). To obtain this result, we weight all cohorts equally (adopting a representative agent view, *VD*) ignoring the demographic structure of the population. In contrast, when we weight the age groups –using the real demographic structure (*VDS*) to compute number of votes – the voting outcomes are considerably different. Only 9 out of 16 countries – most of which are developed – vote in favor of pensions (column 3).

〈Table 6-1〉 Continuation values for public pensions at different ages

Country	*CV20*	*CV30*	*CV40*	*CV50*	*CV60*	*CV70*	*CV80*	*CV90*
Austria	-110 894	-97 826	-23 204	142 071	418 631	586 669	459 283	62 244
Brazil	-1 642	-3 593	-5 779	-6 444	-1 965	28 444	31 323	10 736
Costa Rica	-10 309	-13 422	-12 506	-3 010	26 160	53 725	39 153	4 859
Finland	-78 020	-45 238	50 028	209 332	424 612	466 050	300 588	33 187
Germany	-61 965	-85 616	-68 799	17 858	224 829	384 090	294 339	33 069
Hungary	-59 367	-67 805	-38 552	31 315	146 883	192 686	144 313	18 663
India	-2 450	-2 315	-1 163	1 425	6 579	10 002	7 375	947
Japan	-37 831	-19 698	29 962	125 723	278 041	322 869	169 074	14 202
Mexico	22 487	27 062	36 165	48 291	56 514	47 876	24 098	1 585
Slovenia	-73 531	-73 535	-24 641	67 175	200 241	259 746	177 705	18 311
South Korea	-12 561	-14 975	-13 040	-5 058	12 961	17 899	4 710	144
Spain	-5 256	28 411	106 100	223 495	357 265	368 140	218 172	22 066
Sweden	-80 049	-22 119	117 213	345 670	689 088	808 549	510 958	46 021
Taiwan	-31 918	-31 635	-25 057	-13 188	1 068	4 616	2 938	290
Thailand	-12 509	-12 983	-11 982	-8 574	-2 950	233	147	16
US	-13 596	10 461	83 713	204 920	373 559	410 633	264 103	27 680

Note: *CVa* is the continuation value of the cohort a. For example, *CV20* is the continuation value for cohort aged 20. The negative *CVs* (highlighted in red) denote the reluctance of a particular cohort to support pensions. The positive *CVs* (highlighted in green) denote the willingness of a cohort to support pensions. Continuation values are calculated converting currencies to US dollars (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.

〈Table 6-2〉 Voting scenarios for intergenerational pension and education transfers

	voting on pensions					voting on pensions and education				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	69.0	56.5	65.2	57.7	69.6	69.0	56.5	65.2	57.7	69.6
Brazil	40.8	11.2	78.2	8.4	40.1	40.8	11.2	78.2	8.4	40.1
Costa Rica	54.9	22.6	51.9	22.6	56.8	54.9	22.6	49.4	22.6	56.8
Finland	77.5	73.8	64.6	61.8	75.8	77.5	73.8	64.6	61.8	75.8
Germany	59.2	47.3	69.9	41.3	62.2	59.2	47.3	69.9	41.3	62.2
Hungary	62.0	50.9	57.5	40.4	59.6	62.0	50.9	57.5	40.4	59.6
India	63.4	32.1	37.9	29.2	61.8	63.4	32.1	35.9	29.2	61.8
Japan	78.9	74.2	62.7	57.9	81.9	77.5	72.5	62.7	55.6	80.6
Mexico	100.0	100.0	28.6	100.0	100.0	100.0	100.0	28.6	100.0	100.0
Slovenia	66.2	54.5	60.5	45.8	66.9	66.2	54.5	60.5	45.8	66.9
South Korea	52.1	23.1	29.0	18.1	54.4	49.3	23.0	27.3	18.1	52.5
Spain	94.4	91.9	52.9	88.0	95.4	94.4	91.9	52.9	88.0	95.4
Sweden	81.7	78.6	65.3	73.5	80.5	81.7	78.6	63.4	73.5	80.5
Taiwan	43.7	16.8	15.8	N/A	N/A	40.8	16.7	15.7	N/A	N/A
Thailand	36.6	11.1	11.1	6.9	34.4	0.0	0.0	0.0	0.0	0.0
US	88.7	84.6	51.8	80.7	87.4	87.3	82.7	51.8	78.2	85.8

Note: *VR*: percentage of votes of a cohort-representative agent; *VDS*: vote percentage taking into account the demographic structure of the voting cohorts; VSIR: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4,2%). *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100. Voting outcomes that obtain the majority (over 50%) of the votes (in favor) are highlighted in green and those that obtain majority against (below 50%) in red. Marginal voting outcomes (close to 50%) in favor or against are highlighted in blue.

Equations 1 and 2 from the previous section make apparent that the value of the interest rate plays a key role in the calculation of the continuation value for workers and for retirees, respectively. So next, we examine how the outcomes would be modified if all countries were to "play under the same rules"

(*VSIR*). In other words, we seek to determine how the voting outcomes would change if the continuation values for all countries in our sample were discounted using the same real interest rate. In this way, we control for the fact that the interest rate might significantly affect our results. As is evident from column 4 in Table 2 the voting outcomes in favor or against pensions do not vary significantly from that of the baseline scenario (column 3) for most of the countries in the sample. The exceptions here are Brazil, Costa Rica, Germany and Mexico where the voting outcome is totally shifted (support becomes vote against or vice versa).*

In a second exercise, we consider two different demographic scenarios (Table 2, columns 5 and 6). Essentially, we test what would happen to the voting process if instead of using the demographic structure of each country in the year selected for observation, we employ the demographic structure of the "best" (*BY*) and "worst" (*WY*) years as defined above. As can be seen, we obtain significantly better results in terms of votes during the "worst" year than we do during either the "best" year or the baseline year for each country. This can be understood in terms of political economy, whereby population aging makes the median voter older, thus increasing his/her continuation

* This outcome is due to the high real interest rate in Brazil, Costa Rica and Germany for the particular year and hence higher discount for the future retirement benefits. In the case of Mexico the results are inflated because in the year of our observation the real interest was negative (close to zero) generating very low discount rate and hence inflating the results.

value and making the system politically more popular.* Other sensitive tests are left for the Appendix.**

The next step is to test whether a positive investment in education is maintained (Table 2, columns 7 to 11) and whether a system of intergenerational transfer – where generations link the education to pensions – is politically tenable (Table 3, summarizing the results of Table 2). The system of IGTs like the one linking education to pensions can only receive political backing, if the majority supports both pensions and education transfers. As such, the results of voting on pensions have to be matched by the voting outcomes on education. To conduct this test, we check whether Equation 4 holds for voting age cohorts (20 to 90). If Equation 4 holds for these age groups, this means that the majority of voters are willing to support investments in education, because the system – that links education and pensions –generates a continuation value that is higher than the education tax they have to pay. As illustrated in Table 2,

* See the political economy literature on social security (pensions): [Browning (1975); Boadway and Wildasin (1989); Breyer and Craig (1997); Mulligan and Sala-I-Martin (1999);Tabellini (2000); Persson and Tabellini (2000); Disney (2007); Shelton (2008); Tepe and Vanhuysse (2009); Hollanders and Koster (2012); Michailidis et al.(2016) and Michailids et al. (2019)].

** Table A.1 e provides all the voting scenarios of Table 2 calculating the continuation values using the same real interest rate that equals to 4.2% which represent the average of all countries. Also see Table A.3, where we present the voting outcomes using the average real interest rate for each country during the period 1990-2019. Finally, in Tables 11 and 12 we do not apply the constant productivity growth rate. As expected, for the latter the results show a decrease in sustainability as tax payments increase less than benefits.

Equation 4 holds for the most of the scenarios we have conducted, showing that the viability of a system of pensions and education greatly relies on the vote on pensions. More specifically, only half the countries can support forward IGTs such as education (Table 2 columns 7 and 8). As it is apparent from Table 3 (column 2), a system of pensions and education would receive the support of the majority of voters in 12 out of 16 countries when we consider the representative voter scenario. However, the number of countries drops to 9 when we use the demographic structure of the voting population to calculate the voting outcome. Indeed, if the decision was put to the vote, Austria, Finland, Hungary, Japan, Mexico, Slovenia, Spain, Sweden and the U.S. would vote in favor of a system of pensions and education in our exercise. Moreover, when we impose the same interest rate for all the countries (column 9) we only observe a significant change in support for pensions and education in Brazil Germany and Mexico, compared with the previous scenario (Table 2 column 8).

〈Table 6-3〉 Political sustainability of a system of pensions and education

Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	Sustained	Sustained	Sustained	Sustained	Sustained
Brazil	Not	Not	Sustained	Not	Not
Costa Rica	Sustained	Not	Not	Not	Sustained
Finland	Sustained	Sustained	Sustained	Sustained	Sustained
Germany	Sustained	Not	Sustained	Not	Sustained
Hungary	Sustained	Sustained	Sustained	Not	Sustained
India	Sustained	Not	Not	Not	Sustained
Japan	Sustained	Sustained	Sustained	Sustained	Sustained
Mexico	Sustained	Sustained	Not	Sustained	Sustained
Slovenia	Sustained	Sustained	Sustained	Not	Sustained
South Korea	Not	Not	Not	Not	Sustained
Spain	Sustained	Sustained	Sustained	Sustained	Sustained
Sweden	Sustained	Sustained	Sustained	Sustained	Sustained
Taiwan	Not	Not	Not	N/A	N/A
Thailand	Not	Not	Not	Not	Not
US	Sustained	Sustained	Sustained	Sustained	Sustained

Note: *VR*: percentage of votes of a cohort-representative agent; *VDS*: vote percentage taking into account the demographic structure of the voting cohorts; *VSIR*: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4.2%). *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Sustained: when a linked system of pensions and education transfers would be voted for by the majority. Non-sustained: when not supported by the majority.

Next, in order to examine further the role of population aging in the hypothetical voting that we conduct in this study, we propose a voting scenario using the aged demographic structure – as it is projected in the future- as opposed to the current one. In other words, we investigate what would be the political outcome of the voting if we adopt the demographic structure that is projected to prevail in the future in the countries analysed. Aswe can observe from Table 2 (column 11) most of the countries are in favor of a system of pensions and educa-

tion and would support it if the decision was put to the vote. This indicates that an older electoral body would favor more spending towards pensions and also more spending for a linked system of pensions and education: as population ages, the median voter (working age agent) becomes older and hence more favorable to reallocate public resources towards pensions.

Furthermore, we can observe that some countries either do not obtain or have a fragile voting majority (Thailand and South Korea, respectively). Despite the age structure of population that we use in the "worst year" scenario of Table 2, those countries still do not manage to obtain (or have a tiny majority) the necessary political support in order to have a sustained system of pensions and education. One plausible explanation is that we use the continuation values at an initial period (i.e. Thailand 2004, S. Korea 2000, etc.) where the size of transfers to the elderly is still low (see Figure A.1 in the Appendix). Besides, the extent of population aging, and hence the political power of elderly, is also low in these countries. Consequently, low old dependency ratio can be translated into lower pension benefits, because retirees do not have the necessary political clout to reallocate resources towards themselves. In turn, that means lower continuation value and hence, low support of the middle aged for a common system of pensions and education.

2. Total Public Transfers

After assessing the political sustainability of the common system of public pensions and education, we now conduct the same exercise considering the total public IGTs for the elderly (BITs) and children (FITs). Total public transfers consist of public education, public health, public pensions, public transfers, and other in-kind and in-cash transfers. Each of the categories includes the inflows (benefits) and outflows (taxes) received and paid by individuals during each year of their life. In this case, we employ equation 3 to compute the continuation value of the voting age cohorts.*

As shown in Table 4, when the whole NTA profile of public transfers is taken into account to compute the continuation value, the results are strikingly different. More than half the countries have positive continuation values almost a decade earlier compared to those obtained previously. This indicates that the net present value (benefits received minus taxes payed) of the welfare system is positive for voting cohorts. Therefore, they have strong incentives to support such a system of IGTs.

Nevertheless, there are some countries, including Brazil, Indonesia, the Philippines, South Korea, Taiwan and Thailand,

* Note that when using Equations 1 and 2, we omit taxes paid in dependent ages and benefit received in working ages. This is a minor problem when dealing with retirement pensions and education, but it is of greater importance when referring to all welfare state transfers.

where even older working age cohorts (40-50 years old) present negative current values of the system of welfare transfers.* These differences between countries can be explained by the differences in the structure of their NTA profiles. In other words, countries have different patterns for the reallocation of resources and, therefore, different patterns of IGTs. The aforementioned countries with negative continuation values present similar patterns of IGTs. For most Asian countries, the overall size of public transfers is small and remains quiteconcentrated among young dependents. As such, the age groups reallocate their resources primarily via family transfers as opposed to via publicly funded systems of BITs and FITs (see Appendix for more details, in particular Figure A.1). This might constitute the main reason why the continuation values of total public transfers are negative for most of the voting cohorts in these countries. In contrast, in European countries, public transfers are greater and seem to have crowded out private transfers. Similarly, they are quite clustered around the old, which explains the greater support given by voters, despite the discounting effects.

* Just as before in the case of Brazil (Mexico) the negative (positive) continuation values are mainly driven by the unusually high (low) real interest rate.

〈Table 6-4〉 Continuation values for backward intergenerational transfers

Country	*CV20*	*CV30*	*CV40*	*CV50*	*CV60*	*CV70*	*CV80*	*CV90*
Austria	-106 979	-87 611	26 764	270 909	558 688	610 703	495 588	69 878
Brazil	-546	-4 143	-6 854	-745	11 912	24 361	29 306	11 428
Costa Rica	-9 474	-15 763	-10 945	14 549	53 922	81 444	74 281	11 013
Finland	-69 279	-35 726	124 554	392 030	684 568	686 966	540 977	84 619
Germany	-64 517	-121 521	-96 301	40 365	317 615	461 544	446 854	80 422
Hungary	-59 585	-86 533	-32 261	108 862	304 816	315 019	235 543	30 461
India	-1 887	-1 471	-587	337	1 515	2 297	2 458	946
Indonesia	-8 364	-6 713	-3 984	-718	1 797	2 200	1 256	117
Japan	-51 573	-40 827	34 021	193 278	437 512	498 853	376 788	52 023
Mexico	161 360	154 465	162 943	177 074	169 700	133 701	69 473	3 897
Philippines	-5 130	-6 658	-6 711	-5 543	-1 729	310	-329	-229
Slovenia	-63 355	-68 075	29 190	198 973	360 137	374 478	286 385	33 844
S._Korea	-14 935	-23 164	-13 011	13 995	49 682	54 601	33 577	3 466
Spain	-45 897	-30 100	54 722	199 002	346 004	360 298	240 792	27 735
Sweden	-47 804	7 225	178 853	491 260	958 461	1 144 424	940 348	142 003
Taiwan	-11 867	-12 067	28 632	93 612	146 921	150 140	97 591	10 281
Thailand	-15 852	-19 771	-19 393	-13 506	-4 929	321	2 596	582
US	-1 879	-291	117 106	327 962	618 339	709 153	554 508	98 364

Note: *CVa* is the continuation value of cohort a. For example, CV20 is the continuation value for cohort aged 20. The negative *CVs* (highlighted in red) denote the reluctance of a particular cohort to support total backward public intergenerational transfers (i.e. pensions, healthcare, etc.). Positive *CVs* (highlighted in green) denote the willingness of a cohort to support pensions. Continuation values are calculated converting currencies to US dollars (per capita) based on purchasing power parity (PPP)

Voting outcomes for the total welfare transfers are shown in Tables 5 and 6. Most of the countries in our sample would have voted in favor of a system of total public IGTs (BITs and FITs). More specifically, as shown in Table 6, when we consider a representative voter, 16 out of 18 countries would have backed the system (column 2). The number of countries falls to 10 when we take into account the observed population structure and we weight the votes by the size of each cohort (column 3). Controlling for the interest rate changes the outcomes substantially. Imposing the same real interest rates for all countries changes

the voting outcome in favor (in Brazil, Costa Rica, Germany and S.Korea) and against (in Mexico, Spain Taiwan and the U.S.) of public transfers (column 4).*

Finally, when considering the demographic transition the outcomes vary considerably between the "best" year (column 5), the observed year (column 3) and the "worst" year (column 6). Clearly, populationaging increases the political support for total public transfers directed towards the young (FITs) and the elderly (BITs). In other words, this means that the projected aged demographic structure enhances the political support for such a system. Population ageing fosters politically an extended welfare state.

At this juncture, we should stress that differences in outcomes between the previous and the current sections are due primarily to the differences in the data used. In this section, we take into account all the public transfers made in each country. This means, the continuation value of each cohort is measured including the present value of all benefits received and all taxes paid. In contrast,

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* In the appendix Table A.2 we provide all the voting scenarios of Table 5 calculating the continuation values using the same real interest rate that equals to 4.2%which represent the average of all countries. Also see Table A.4, where we present the voting outcomes using the average real interest rate for each country during the period 1990-2019. At this juncture, we should stress that differences in outcomes between the previous and the current sections are due primarily to the differences in the data used. In this section, we take into account all the public transfers made in each country. This means, the continuation value of each cohort is measured including the present value of all benefits received and all taxes paid. In contrast, the continuation value of pensions and education takes into account only the pension benefits received when retired and the social contributions paid when working. Hence, many of the benefits that young and working age population (a = 20...64) receive are included in the calculation of the continuation value in this section, but not in the previous one.

the continuation value of pensions and education takes into account only the pension benefits received when retired and the social contributions paid when working. Hence, many of the benefits that young and working age population (a=20...64) receive are included in the calculation of the continuation value in this section.

〈Table 6-5〉 Voting scenarios for total BITs and FITs

	Voting on *BITs*					Voting on *BITs* and *FITs*				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	73.2	62.9	74.5	64.3	73.9	73.2	62.9	74.5	64.3	73.9
Brazil	56.3	23.4	100	20.8	57	56.3	23.4	100	20.8	57
Costa Rica	63.4	33.2	76.3	30.7	65.4	63.4	33.2	73.7	30.7	65.4
Finland	81.7	78.8	68.3	68.3	80.3	80.3	77.2	68.3	66.2	78.8
Germany	60.6	49.1	69.9	43.5	63.7	59.2	47.3	69.9	41.3	62.2
Hungary	66.2	56	63.8	46.7	64.4	66.2	56	63.8	46.7	64.4
India	63.4	32.1	35.9	29.2	61.8	60.6	28.5	32.1	25.8	58.6
Indonesia	53.5	19.9	14.4	19.5	51.9	50.7	18.6	13.4	18.1	49.8
Japan	76.1	70.8	61.1	53.4	79.3	76.1	70.8	61.1	53.4	79.3
Mexico	100	100	46.1	100	100	100	100	43.9	100	100
Philippines	14.1	3.3	3.3	3.4	13.9	7	1.7	1.3	1.8	7
Slovenia	74.6	66.3	71.9	59.6	76.1	74.6	66.3	71.9	59.6	76.1
South Korea	63.4	35.9	50.3	30.4	65.6	62	34	50.3	28.8	64.2
Spain	78.9	68.6	46.1	61.1	81.3	78.9	68.6	46.1	61.1	81.3
Sweden	85.9	84.1	65.3	80	85	85.9	84.1	65.3	80	85
Taiwan	80.3	65.8	41.2	N/A	N/A	78.9	63.3	38.9	N/A	N/A
Thailand	29.6	6.9	6.2	3.9	26.2	28.2	6.2	5.5	3.4	24.6
US	84.5	78.9	49.6	73.4	82.7	84.5	78.9	47.5	73.4	82.7

Note: *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *VSIR*: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4,2%). *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year: Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Indonesia (1965, 2095), Japan (1950, 2051), Mexico (1955,2095), Philippines (1995, 2100), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950,2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio is assessed in the period between 1950 and 2100. Voting outcomes that obtain the majority (over 50%) of the votes (in favor) are highlighted in green and those that obtain majority against (below 50%) in red. Marginal voting outcomes (close to 50%) in favor or against are highlighted in blue.

These benefits might include, for example, health care or other in-kind or in-cash transfers that these voting cohorts receive from the welfare state. Thus, in present values working age population benefit more from a system of total public transfers than they do from a linked system of pensions and education. Thus, by including a broader spectrum of transfers it is plausible to assume that more votes can be attracted from working age population (a = 20...64).

Our results should be interpreted considering some limitations of our approach. First, we are working in a constant policy scenario, implying that agents are myopic to foreseeable cuts in net benefits (future tax increases or benefits reductions) to meet financial sustainability. However, in a real context voters'expectations could change and affect their support to policies. Second, our representative agent approach ignores heterogeneity in educational attainment and, hence, the fact that the high educated might substitute public by private education. This should hardly affect the results in European countries, where private education expenditure is very low, but it could be have some effect in the US and Asian countries. Both issues imply that our results would be overestimating the political support to the system.

〈Table 6-6〉 Political sustainability of total public transfers

Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	Sustained	Sustained	Sustained	Sustained	Sustained
Brazil	Sustained	Not	Sustained	Not	Sustained
Costa Rica	Sustained	Not	Sustained	Not	Sustained
Finland	Sustained	Sustained	Sustained	Sustained	Sustained
Germany	Sustained	Not	Sustained	Not	Sustained
Hungary	Sustained	Sustained	Sustained	Not	Sustained
India	Sustained	Not	Not	Not	Sustained
Indonesia	Sustained	Not	Not	Not	Not
Japan	Sustained	Sustained	Sustained	Sustained	Sustained
Mexico	Sustained	Sustained	Not	Sustained	Sustained
Philippines	Not	Not	Not	Not	Not
Slovenia	Sustained	Sustained	Sustained	Sustained	Sustained
South Korea	Sustained	Not	Sustained	Not	Sustained
Spain	Sustained	Sustained	Not	Sustained	Sustained
Sweden	Sustained	Sustained	Sustained	Sustained	Sustained
Taiwan	Sustained	Sustained	Not	Not	Not
Thailand	Not	Not	Not	Not	Not
US	Sustained	Sustained	Not	Sustained	Sustained

Note: *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *VSIR*: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4.2%). *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Sustained: when a linked system of pensions and education transfers would be voted for by the majority. Non-sustained: when not supported by the majority.

Final remarks

Our results indicate that the welfare state as it is now is politically sustainable. First the voting outcome of the pensions system according to the current demographic structure is sustainable is 56% of countries and it becomes even more sustainable if population ages (87% of countries support it). The same is

true for the joint system of pensions and education. It is marginally less sustainable, but still the same share of the countries in our sample would sustain it under current population and even more if population ages. In other words, paying for education does not decrease the net payment received pensions. A similar pattern occurs when considering total backward intergenerational public transfers (BITs) alone or a joint system of backward and forward intergenerational public transfers (BITs and FITs). One of the main reasons of this outcome seems to be the life cycle pattern of welfare state transfers, which turns out to be biased towards the elderly, combined with the fact that children do not vote.

Unfortunately, political sustainability does not go in the same direction as financial sustainability. Ageing increases the political sustainability by increasing the political power of the elderly, but shrinks labor force undermining the possibility to finance the transfers to an increasing number of elders. Nevertheless, a linked system of education and pensions might soften these tensions. A higher continuation value for the median voter can be invested in education making the joint system of pensions and education politically more viable (Rangel, 2003). Thus, pensions can foster education. This, in turn, improves the future financial prospects of the PAYG system. Higher investment in education can boost the productivity of future workers and consequently the level of their contributions to social security

and revenues from taxing their income. The immediate policy conclusion is that pensions could be pre-funded by increasing education expenditure. Moreover, we can suggest thatit might be a useful reform to require legislation to vote on pensions and education as a unique social policy package. This reasoning could also be applied to a broader spectrum of intergenerational transfers.

Welfare state policies constitute one of the greatest achievements of the past century, well worth maintaining. However, in order to evaluate its impact on welfare it is necessary to take a comprehensive view of the human lifecycle. Unprotecting children seems dangerous. On the one hand, besides the potential negative impact on equality of opportunities, a loose education policy might also have irreversible effects in future human capital growth failing to prefund pay-as-you-go financed pensions. On the other hand, it may negatively affect birth rates, a main factor of demographic change. In fact, there seems to be a counterproductive "dog chasing its own tail"effect, as policies that affect negatively fertility actually harm the welfare state's own financial sustainability. Actually, the imminent ageing process urges deriving imaginative policies to help the so-called "sandwich-generation"(working age population) in sustaining the increasing number of elderly people without decreasing fertility or investment in education.

Overall, it seems clear that a more balanced welfare state

model towards children and the elderly would be more sustainable in global terms. On the one hand, it would help to smooth the demographic transition in developing countries, avoiding too strong demographic cycles like theones present in Spain, Italy and other countries, where the baby boom and baby bust were sharp and strong. Hence, such a system would be more implementable in developing countries. In addition, the extension of the welfare state to these countries would not only foster welfare of their citizens but also reduce wage differentials and, hence, would make the welfare states in a globalized world more sustainable.

Appendix

〈Table A.1〉 Voting scenarios on pensions and education (same real interest rates for each country)

	Voting pensions				Voting pensions and education			
Country	*VR*	*VDS*	*BY*	*WY*	*VR*	*VDS*	*BY*	*WY*
Austria	74.6	65.2	66.4	75.3	74.6	65.2	66.4	75.3
Brazil	90.1	78.2	74.1	90.8	90.1	78.2	74.1	90.8
Costa Rica	74.6	51.9	43.9	76.5	73.2	49.4	42.1	75.1
Finland	70.4	64.6	50.2	68.4	70.4	64.6	50.2	68.4
Germany	74.6	69.9	66.7	77.6	74.6	69.9	66.7	77.6
Hungary	67.6	57.5	48.9	66	67.6	57.5	48.9	66
India	67.6	37.9	35	66.5	66.2	35.9	32.9	64.9
Japan	69	62.7	42.6	72.7	69	62.7	42.6	72.7
Mexico	60.6	28.6	26.9	60.9	60.6	28.6	26.9	60.9
Slovenia	70.4	60.5	52.8	71.5	70.4	60.5	52.8	71.5
South Korea	57.7	29	24.2	60	53.5	27.3	22.6	56.7
Spain	67.6	52.9	44.3	69.4	67.6	52.9	44.3	69.4
Sweden	71.8	65.3	58.1	70	70.4	63.4	55.9	68.5
Taiwan	42.3	15.8	N/A	N/A	39.4	15.7	N/A	N/A
Thailand	36.6	11.1	6.9	34.4	0	0	0	0
US	66.2	51.8	44.5	62.5	66.2	51.8	44.5	62.5

Note: In this Table we present all the voting outcomes from Table 2 recalculating the continuation values using the same real interest rate (4.2%, the average of all countries in the year of the observation) for all countries in the sample. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.

〈Table A.2〉 Voting scenarios on FITs and BITs (same real interest rate)

	Voting *BITs*				Voting *BITs* and *FITs*			
Country	*VR*	*VDS*	*BY*	*WY*	*VR*	*VDS*	*BY*	*WY*
Austria	80.3	74.5	73.8	81.1	80.3	74.5	73.8	81.1
Brazil	100	100	100	100	100	100	100	100
Costa Rica	88.7	76.3	68.5	89.8	87.3	73.7	65.2	88.5
Finland	73.2	68.3	54.9	71.4	73.2	68.3	54.9	71.4
Germany	74.6	69.9	66.7	77.6	74.6	69.9	66.7	77.6
Hungary	73.2	63.8	58.1	72.3	73.2	63.8	58.1	72.3
India	66.2	35.9	32.9	64.9	63.4	32.1	29.2	61.8
Indonesia	46.5	14.4	13.2	44.2	43.7	13.4	12.1	42
Japan	67.6	61.1	40.6	71.4	67.6	61.1	40.6	71.4
Mexico	73.2	46.1	43.3	73.9	71.8	43.9	41.4	72.5
Philippines	14.1	3.3	3.4	13.9	5.6	1.3	1.4	5.6
Slovenia	78.9	71.9	65.7	80.5	78.9	71.9	65.7	80.5
South Korea	71.8	50.3	43.2	74	71.8	50.3	43.2	74
Spain	62	46.1	36.5	63.5	62	46.1	36.5	63.5
Sweden	71.8	65.3	58.1	70	71.8	65.3	58.1	70
Taiwan	66.2	41.2	N/A	N/A	64.8	38.9	N/A	N/A
Thailand	28.2	6.2	3.4	24.6	26.8	5.5	3	23
US	64.8	49.6	42.7	61	63.4	47.5	40.9	59.4

Note: In this Table we present all the voting outcomes from Table 5 recalculating the continuation values using the same real interest rate (4.2%, that is the average of all countries in the year of observation) for all countries in the sample. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. BY: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.

〈Table A.3〉 Voting scenarios on pensions and education
(average real interest rate 1990-2019)

	Voting pensions					Voting pensions				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	66.2	52.6	50.8	53.3	66.8	66.2	52.6	50.8	53.3	66.8
Brazil	43.7	13	45.5	10.2	43.2	43.7	13	45.5	10.2	43.2
Costa Rica	56.3	24.2	35.3	23.9	58.3	56.3	24.2	35.3	23.9	58.3
Finland	71.8	66.5	55	52.6	69.9	71.8	66.5	53.1	52.6	69.9
Germany	59.2	47.3	54.7	41.3	62.2	59.2	47.3	54.7	41.3	62.2
Hungary	70.4	60.6	50.9	53.4	69.1	70.4	60.6	50.9	53.4	69.1
India	62	30.3	26.7	27.4	60.2	60.6	28.5	26.7	25.8	58.6
Japan	83.1	79.9	53.5	64.6	85.6	83.1	79.9	53.5	64.6	85.6
Mexico	66.2	35.8	23.8	33.6	66.7	64.8	33.9	22.4	31.8	65.3
Slovenia	46.5	28	50.5	19.1	46.5	46.5	28	50.5	19.1	46.5
South Korea	56.3	27.4	24.5	22.7	58.6	53.5	27.3	24.4	22.6	56.7
Spain	66.2	51.2	44.5	42.3	67.9	66.2	51.2	44.5	42.3	67.9
Sweden	63.4	54.5	52.8	45.2	60.8	63.4	54.5	52.8	45.2	60.8
Taiwan	43.7	16.8	14.8	N/A	N/A	40.8	16.7	14.7	N/A	N/A
Thailand	36.6	11.1	11.1	6.9	34.4	0	0	0	0	0
US	69	56.3	41.2	48.6	65.6	69	56.3	41.2	48.6	65.6

Note: In this Table we recalculate the continuation values and hence all the voting outcomes from Table 2 using this time instead of the real interest rate of the year of observation for each country the average real interest rate during the period 1990-2019. Although, the percentages in the voting scenarios have changed we do not observe any dramatic shifts. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. BY: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.

〈Table A.4〉 Voting scenarios on BITs and FITs
(average real interest rate 1990-2019)

	Voting on *BITs*					Voting on *BITs* and *FITs*				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	71.8	60.7	58.6	62.1	72.5	71.8	60.7	58.6	62.1	72.5
Brazil	57.7	24.8	61.0	22.3	58.5	57.7	24.8	61.0	22.3	58.5
Costa Rica	64.8	35.3	54.3	32.1	66.8	64.8	35.3	51.9	32.1	66.8
Finland	76.1	72.0	58.8	59.6	74.4	74.6	70.2	58.8	57.3	72.9
Germany	60.6	49.1	56.7	43.5	63.7	60.6	49.1	56.7	43.5	63.7
Hungary	77.5	69.1	56.0	65.2	76.9	76.1	67.3	56.0	63.0	75.4
India	62.0	30.3	28.5	27.4	60.2	57.7	25.0	21.8	22.6	55.4
Indonesia	45.1	13.5	13.5	12.1	42.6	42.3	12.5	12.5	11.0	40.4
Japan	81.7	77.9	53.5	62.4	84.4	80.3	76.1	53.5	60.1	83.1
Mexico	84.5	66.7	37.7	62.4	85.1	83.1	63.8	35.8	59.5	83.7
Philippines	14.1	3.3	3.3	3.4	13.9	7.0	1.7	1.9	1.8	7.0
Slovenia	54.9	38.5	62.5	28.7	54.9	54.9	38.5	62.5	28.7	54.9
South Korea	71.8	50.3	40.2	43.2	74.0	70.4	47.7	40.2	40.9	72.6
Spain	62.0	46.1	41.4	36.5	63.5	62.0	46.1	41.4	36.5	63.5
Sweden	63.4	54.5	52.8	45.2	60.8	63.4	54.5	52.8	45.2	60.8
Taiwan	80.3	65.8	32.5	N/A	N/A	78.9	63.3	32.5	N/A	N/A
Thailand	28.2	6.2	5.5	3.4	24.6	25.4	4.9	4.9	2.7	21.3
US	66.2	51.8	39.2	44.5	62.5	66.2	51.8	39.2	44.5	62.5

Note: In this Table we recalculate the continuation values and hence all the voting outcomes from Table 5 in the main text using this time instead of the real interest rate of the year of observation for each country the average real interest rate during the period 1990-2019. Although, the percentages in the voting scenarios have changed we do not observe any dramatic shifts. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.

〈Table A.5〉 Voting scenarios on pensions and education
(not adjusted for productivity growth)

	Voting pensions					Voting pensions				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	62	47.3	52.6	46.6	62.5	62	47.3	52.6	46.6	62.5
Brazil	40.8	11.2	47.8	8.4	40.1	40.8	11.2	47.8	8.4	40.1
Costa Rica	52.1	19.8	37.4	20.1	53.9	52.1	19.8	35.3	20.1	53.9
Finland	67.6	60.7	55	45.5	65.4	67.6	60.7	55	45.5	65.4
Germany	56.3	43.7	56.7	37	59.1	56.3	43.7	56.7	37	59.1
Hungary	57.7	45.3	50.9	34.5	54.9	57.7	45.3	50.9	34.5	54.9
India	57.7	25	28.5	22.6	55.4	57.7	25	26.7	22.6	55.4
Japan	66.2	59.6	55.1	38.7	70.1	66.2	59.6	55.1	38.7	70.1
Mexico	83.1	63.8	23.8	59.5	83.7	80.3	60.9	23.8	56.7	81.5
Slovenia	62	48.6	52.5	39	62.2	62	48.6	52.5	39	62.2
South Korea	50.7	21.8	25.9	16.7	53	43.7	20.3	24.2	15.3	47.6
Spain	73.2	60.5	46.1	52.5	75.4	73.2	60.5	44.5	52.5	75.4
Sweden	69	61.6	54.5	53.7	67	69	61.6	54.5	53.7	67
Taiwan	43.7	16.8	15.8	N/A	N/A	35.2	15.4	14.4	N/A	N/A
Thailand	36.6	11.1	11.1	6.9	34.4	0	0	0	0	0
US	70.4	58.5	43.2	50.8	67.2	70.4	58.5	41.2	50.8	67.2

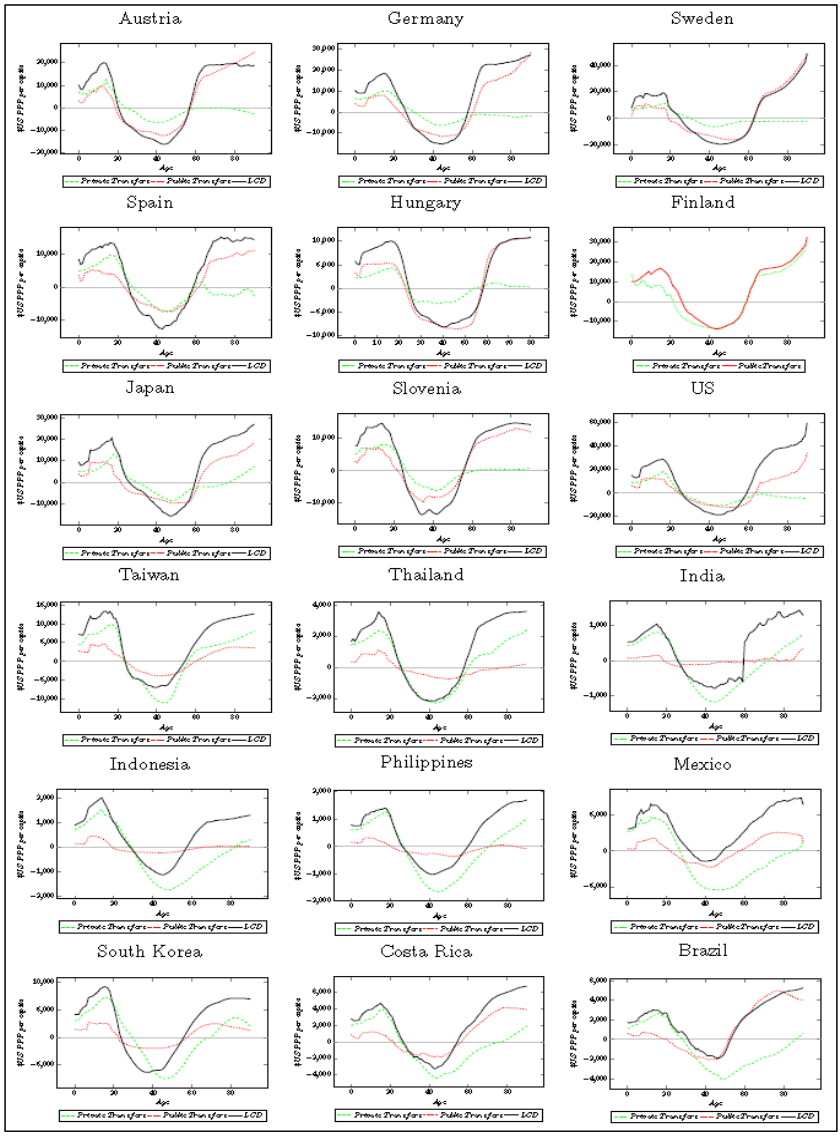
Note: In this Table we recalculate the continuation values and hence all the voting scenarios from Table 2 in the main text, but this time not adjusting for constant annual productivity rate of 1.5% and using the interest rate of each country in the year of the observation. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *VSIR*: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4.2%). BY: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.

〈Table A.6〉 Voting scenarios on BITs and FITs (not adjusted for productivity growth)

	Voting on ***BITs***					Voting on ***BITs*** and ***FITs***				
Country	*VR*	*VDS*	*VSIR*	*BY*	*WY*	*VR*	*VDS*	*VSIR*	*BY*	*WY*
Austria	67.6	54.5	60.7	55.5	68.2	67.6	54.5	58.6	55.5	68.2
Brazil	56.3	23.4	63.9	20.8	57.0	54.9	22.1	63.9	19.4	55.5
Costa Rica	60.6	29.4	54.3	27.9	62.6	60.6	29.4	54.3	27.9	62.6
Finland	70.4	64.6	58.8	50.2	68.4	70.4	64.6	58.8	50.2	68.4
Germany	57.7	45.5	56.7	39.1	60.7	56.3	43.7	56.7	37.0	59.1
Hungary	63.4	52.7	57.5	42.5	61.2	62.0	50.9	57.5	40.4	59.6
India	57.7	25.0	28.5	22.6	55.4	50.7	17.5	20.3	15.4	47.2
Indonesia	50.7	17.5	13.5	16.8	48.9	40.8	15.2	11.5	14.2	41.8
Japan	64.8	58.0	53.5	36.8	68.8	64.8	58.0	53.5	36.8	68.8
Mexico	100	100	37.7	100	100	100	100	37.7	100	100
Philippines	14.1	3.3	3.3	3.4	13.9	0	0	0	0	0
Slovenia	69.0	58.5	62.5	50.5	70.0	69.0	58.5	62.5	50.5	70.0
South Korea	60.6	32.3	40.2	27.2	62.8	59.2	30.6	40.2	25.7	61.4
Spain	67.6	52.9	41.4	44.3	69.4	66.2	51.2	41.4	42.3	67.9
Sweden	70.4	63.4	54.5	55.9	68.5	69.0	61.6	54.5	53.7	67.0
Taiwan	69.0	45.8	34.6	N/A	N/A	69.0	45.8	32.5	N/A	N/A
Thailand	28.2	6.2	5.5	3.4	24.6	21.1	4.2	3.7	2.3	18.5
US	67.6	54.1	39.2	46.5	64.1	67.6	54.1	39.2	46.5	64.1

Note: Table we recalculate the continuation values and hence all the voting scenarios from Table 5 in the main text, but this time not adjusting for constant annual productivity rate of 1.5% and using the interest rate of each country in the year of the observation. *VR*: percentage of votes of a cohort-representative agent. *VDS*: vote percentage taking into account the demographic structure of the voting cohorts. *VSIR*: vote percentage when apart from the imposed real demographic structure, *CVs* are gauged with same interest rate for all countries (4,2%). *BY*: Best year, the year of the lowest old-age dependency ratio. *WY*: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Indonesia (1965, 2095), Japan (1950, 2051), Mexico (1955,2095), Philippines (1995, 2100), Slovenia (1950, 2055), South Korea (1950, 2064), Spain (1950,2050), Sweden (1950, 2095), Taiwan (N/A, data not available), Thailand (1950, 2075), US (1950, 2100). The old dependency ratio is assessed in the period between 1950 and 2100.

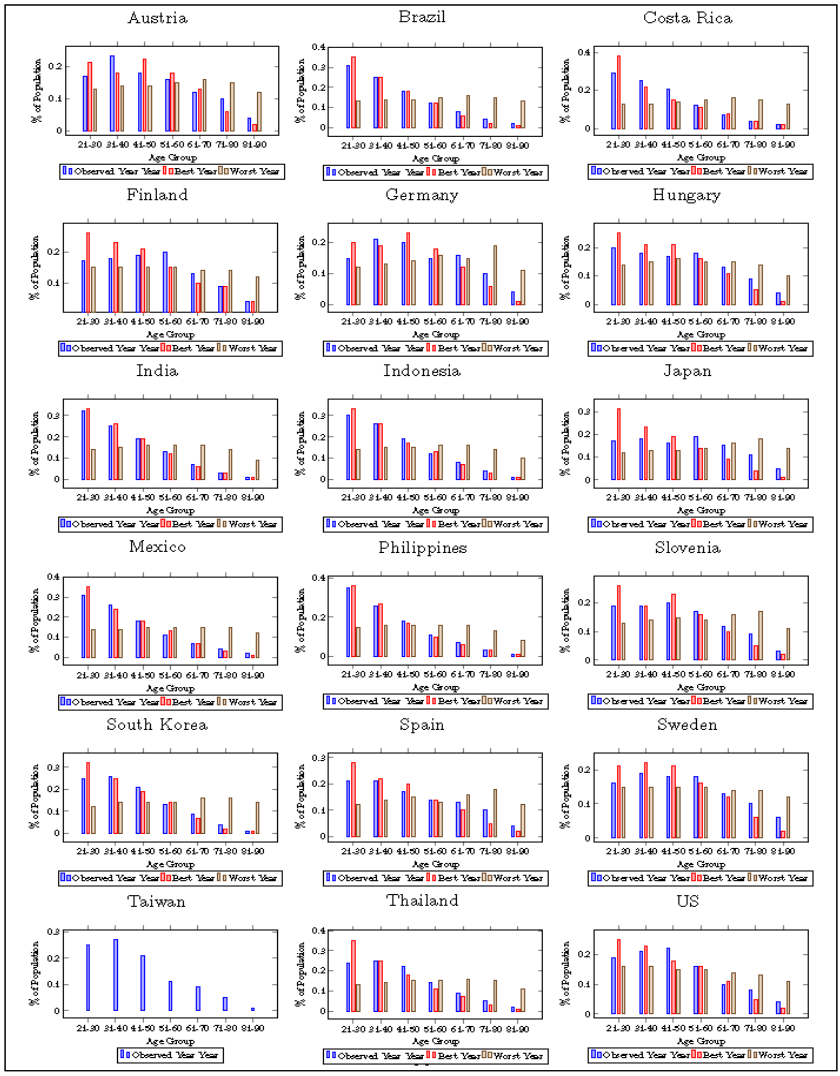
[Figure A.1] Intergenerational transfers structure and life cycle deficit



Note: LCD: Life cycle deficit. TG: Public transfers. TF: Private transfers. LCD, TG and TF values are calculated converting currencies to US dollars (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.

Source: Authors' elaboration using NTA data (www.nta.org)

[Figure A.2] Demographic transition, population aging per country



Note: Observation year is the year that each country is observed in the sample. The "best" and "worst"year are identified using the old dependency ratio (not available for Taiwan). Hence the "best" ("worst") year is the year with the lowest (highest) old dependency ratio. As we can see population aging has a substantial impact on the demographic structure of the voting cohorts.

Source: Authors' elaboration using NTA data (www.nta.org)

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