Does Longevity Boost or Depress Savings?[*]
Evidence from Korea

Myung Soo Cha
mscha@ynu.ac.kr

This paper analyzes the aggregate time series data from 1925-2015 and the micro panel data from 2012-16 for South Korea to show that the improvement in old age survival chances boosted, rather than depressed, savings. Positively correlated with the income growth as experienced by household heads in their early teens, the cohort effect on household savings ratio as estimated using the micro panel data depended negatively on the probability of dying from age 65-79 they observed at age ten. As the analysis of time series data indicated, old age mortality adversely affected the Korean domestic savings ratio from 1925-2015, which hardly depended on old age dependency.

Keywords: old age mortality; savings; life cycle savings; old age dependency
JEL classification: E21, J11

[*] This paper was supported by the research fund from the Academy of Korean Studies (AKS-2014-KFR-123001).

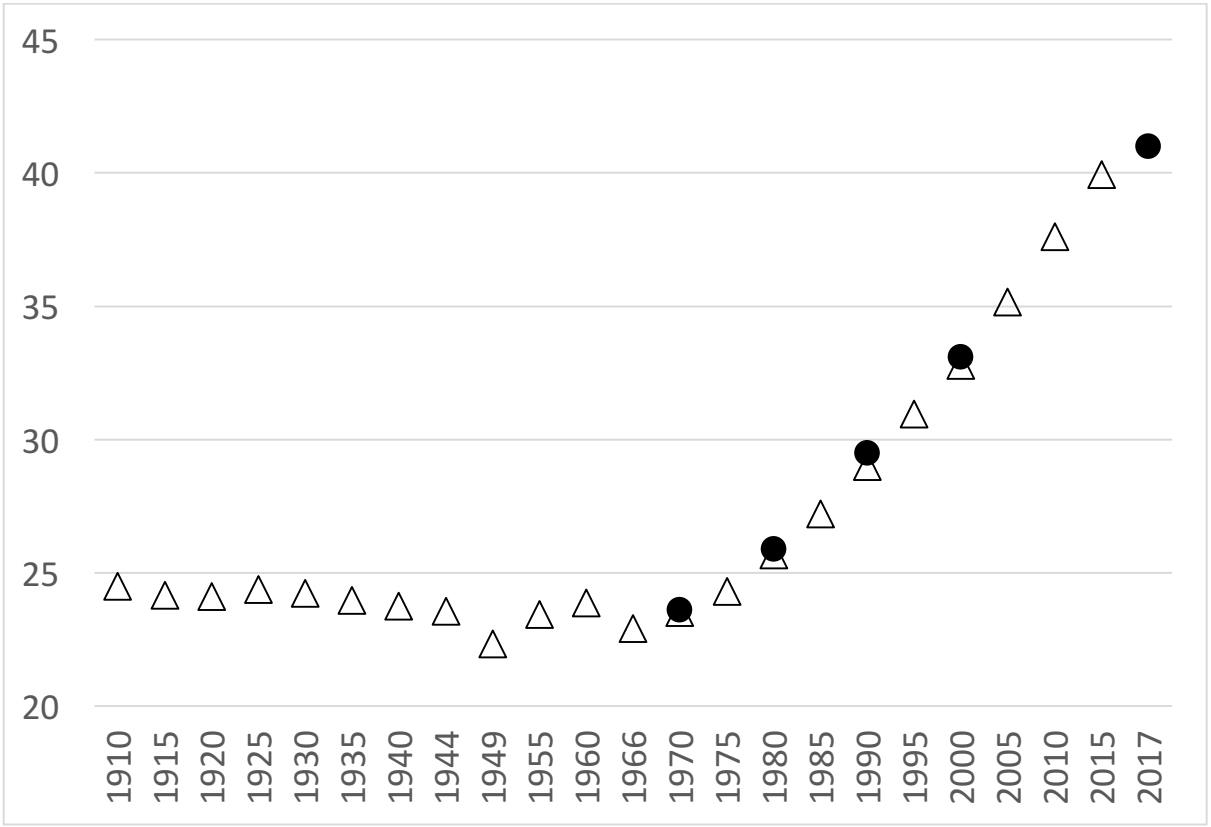
Demographic transition -- the changeover from a high fertility and mortality to a lower fertility and mortality regime -- entails populating ageing. Fertility transition causes the share of children in the population to fall, increasing the average age of population. While the average age declines as infant mortality falls in the earlier phase mortality transition, in the subsequent stage the benefit of improving chances of survival is reaped largely by the elderly, which raises the average age.

The world population has been ageing for at least half a century as is indicated by the average age rising from 28 in 1950 to 32 in 2011 (*The Economist*, January 8, 2013, "The age of man"). From 1959-2015, the average age of South Koreans rose far more rapidly, from 22 to 40. While the population ageing was initially driven by the rapid fertility transition occurring from 1960-85, in the ensuing decades the decline in old age mortality caused the rise in the average age.

This paper identifies the impact of improving old age survival chances on savings. To do so, I use two distinct type of evidence, including the aggregate time series from 1925-2015 and the micro panel data generated by the South Korean surveys on financial welfare of households from 2012-16. The first section motivates the inquiry with an outline of the South Korean ageing, a brief survey of literature, and a simulation exercise. The second section analyzes the micro panel data to show that improving chance of survival for the elderly encouraged working age population to save more for old age security. In the third section, I present time series evidence of the stimulus more than cancelling out the depressing effect of rising old age dependency on the saving. The final section concludes.

Background and Issues

Figure 1 Average Age of South Koreans, 1911-2015

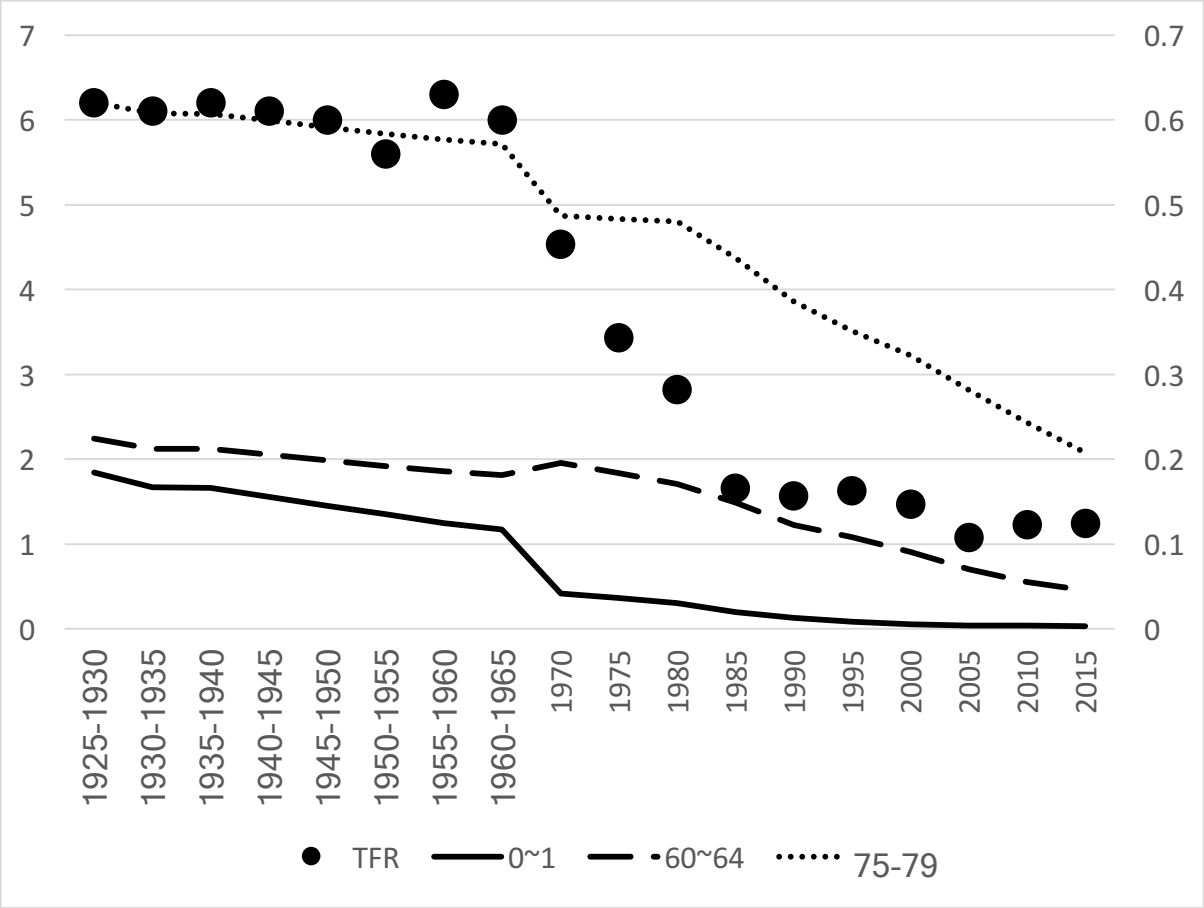


Sources: National Statistical Office, *Changnaein'guch'ugye*; 2017; *Haengjŏngjach'it'onggyeyŏnbo*

Notes: triangles – estimates based on population by age group; circles – official estimates

Figure 1 presents the average age of Koreans as caculated using population by quinquennial age group from 1910-2015 (triangles), which stay reasonably close to the direct estimates published by the National Statistical Office of South Korea (circles). After the slow decline in the first half of the twentieth century, the average age nearly doubled from 22 in 1949 to 41 in 2017.

Figure 2 Total Fertility and Age-Specific Mortality Rates, 1925-2015

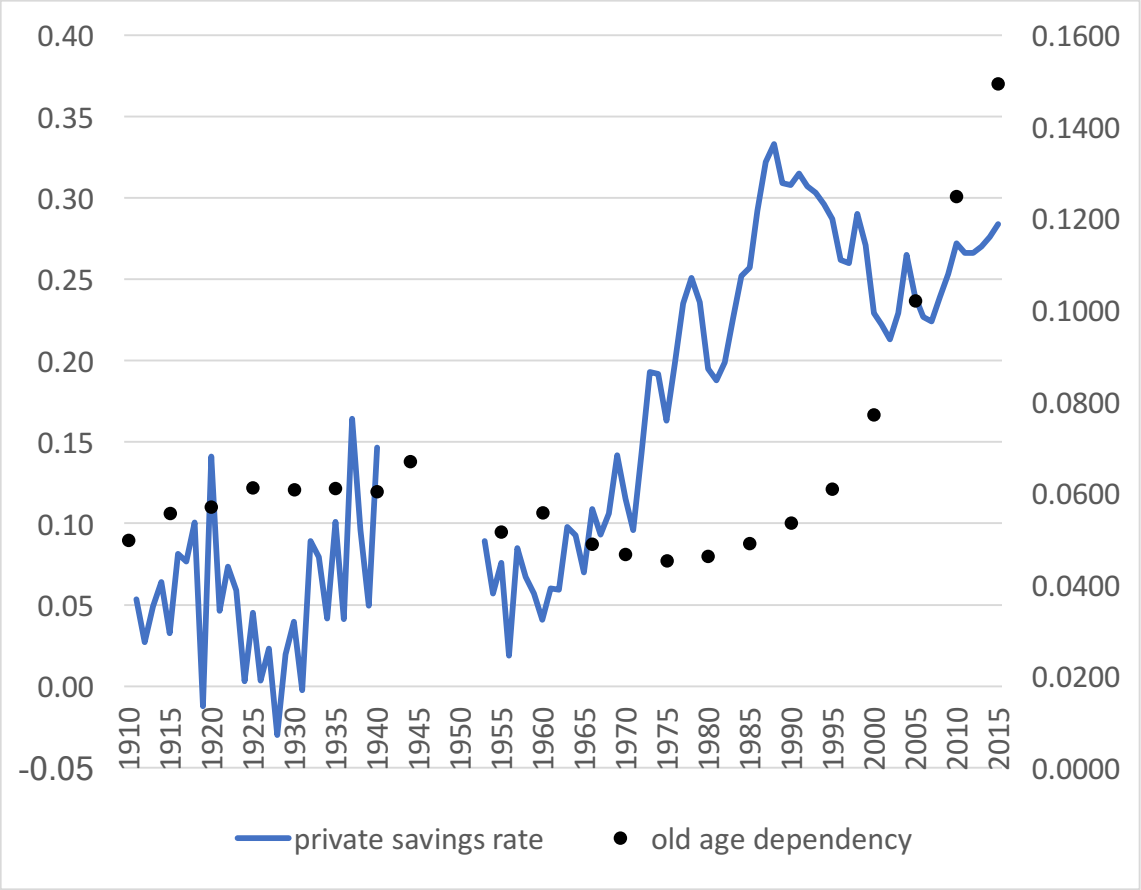


Sources: Kwon(1977); kosis.kr

Notes: circles – total fertility rate; solid line - ${}_1q_0$; broken line - ${}_5q_{60}$; dotted line - ${}_5q_{75}$; total fertility rate – left axis; age-specific mortality rates – right axis.

The population ageing occurring in South Korea in the past half century was attributable more to increasing longevity, than to fertility decline. From 1960-85, when total fertility rate fell from 6.0 to 1.7, the average age of the population rose by three years, which was followed by an increase in the average age of fourteen years from 1985-2017, when fertility decline slowed down substantially, but the decline in old age mortality speeded up significantly (Figure 2).

Figure 3 Old Age Dependency and Private Savings Ratio



Sources: Kim(2012); Kwon(1977); kosis.kr

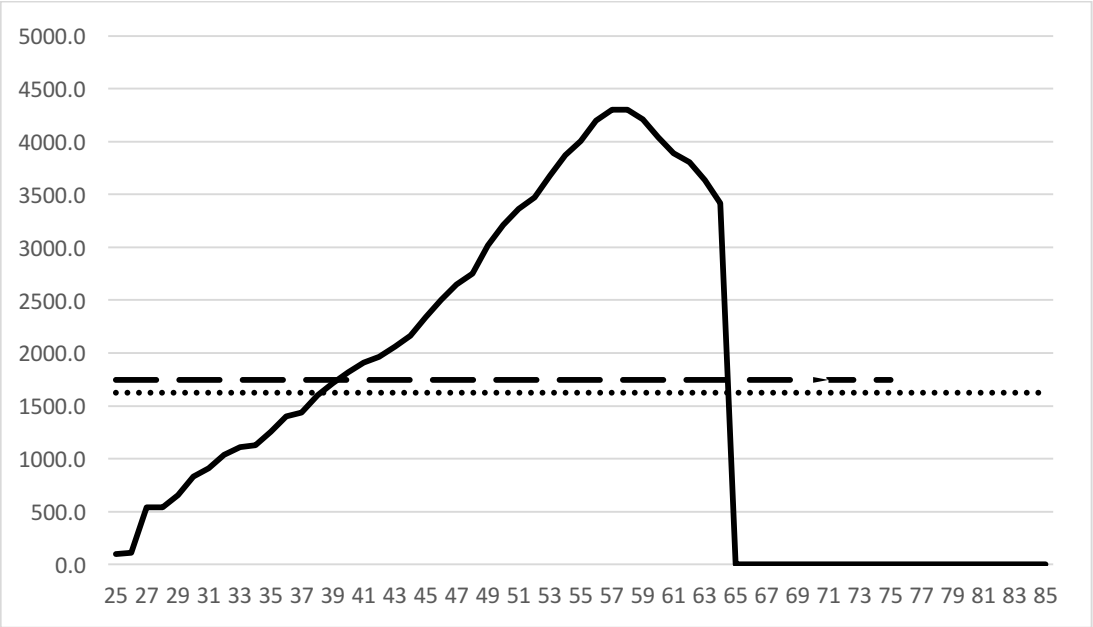
Note: savings rate – left axis; dependency rate – right axis.

The population ageing is indicated also by rising old age dependency, defined as population aged 65 and older relative to population aged 15-64. As seen in Figure 3, after remaining trendless for more than seven decades, old age dependency tripled from 5% in 1985 to 15% in 2015. Figure 3 shows that as old age dependency rose in recent decades, the private savings ratio declined, a correlation, which might lead the proponents of the demographic dividend hypothesis to interpret it as evidence of population ageing depressing savings. Different studies, including Kang(1994) and Higgins and Williamson(1997), attributed the post-1960 rise in Asian savings, including the South Korean savings boom from 1960-90 as seen in Figure 3, to the decline in youth dependency brought about by fertility transition.[1] The causal link of the rising population share of is only a part of the whole story about how declining old age mortality affects savings however. As Fogel(1994, 1997) argued,

[1] Coale and Hoover(1958) highlighted the decline in infant mortality, which raises youth dependency burden, as a potential cause depressing savings.

increasing life expectancy is associated with improving health, which raises labor productivity, hence earnings and the savings ratio. More importantly, in the framework of the life-cycle theory, rising longevity prompts working age population to save more to provide for longer post-retirement life, at least partly offsetting the adverse impact of ageing on the aggregate savings through the dependency channel (Disney(1996); Bloom, Canning, and Graham(2003)).

Figure 4 Shifts in Consumption and Wage Earnings Over Age



Notes: solid line denotes age-earnings profile as estimated using micro-panel data; the level of earning at age twenty five was set equal to 100 and to zero from age sixty five on; broken and dotted lines represent consumption paths for lifetime of seventy five and eighty five years, respectively, which were obtained as solution for the dynamic optimization problem described in the text.
Source: micro-panel data generated by the Surveys on Household Financial Welfare from 2012-16.

Consider a typical worker whose earnings shift over age following the solid line in Figure 4, an age-earning profile estimated using the micro-panel data collected by the Survey on the

Household Financial Welfare of from 2012-16.[2] His earnings rises by roughly forty-three-fold from age twenty five to fifty eight, which is followed by a 20% decline in the subsequent six years leading up to retirement. Assume that she has perfect foresight and, in particular, knows the wage-earning profile and the arrival of death with certainty at age seventy five, and that in the perfectly functioning capital market the riskless rate of interest remains fixed at r. The wage earner enters the labor market at twenty five with no wealth, and she passes away at seventy leaving no assets. The flow of her life time consumption and savings and the path of wealth accumulation can be known by solving the following maximization problem:

$$\text{Max } \sum_{25}^{T} \theta^{t-25} \ln(c_t)$$

s.t.

$$\Delta W = w_t + rW_t - c_t,$$

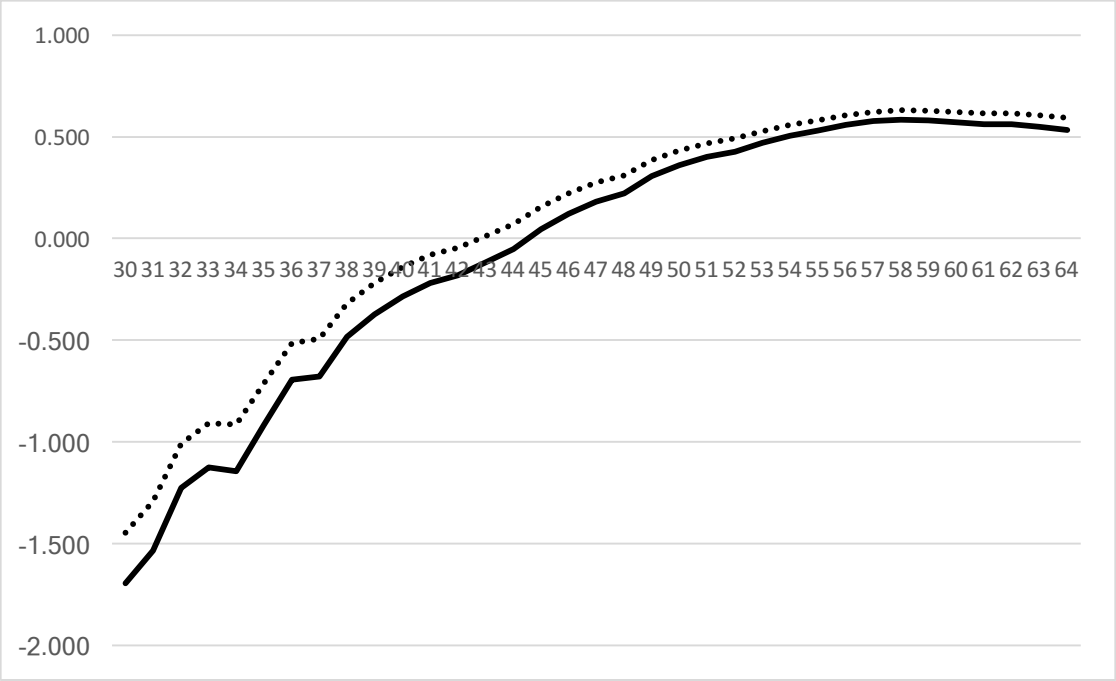
and

$$W_{25} = W_T = 0.$$

where c_t, w_t, and $_t$ denote, respectively, consumption, wage income, and wealth at age t. The lifetime, T, is set initially equal to seventy five. The rate of interest, r, is assumed to remain fixed over the life time at 3%, and by convention the private discount rate, ρ, is set equal to the rate of interest rate, hence θ (=1/(1+ρ)), the period discount rate, equal to 0.97.

Figure 5 Simulated Effect of Longevity on Savings Ratio

[2] Details of this data source are provided in the following section. The age-earning profile represents the coefficients of the dummy variables indicating the age of household heads. The right-hand side variable also included dummy variables representing survey years and the birth year of household heads.



Note: solid line – death at 75; dotted line – death at 85; horizontal axis – ages; vertical axis – savings ratio; savings ratio up to age 29 was suppressed for the sake of readability.
Source: author's calculation; see text.

In this setup, the equilibrium path of consumption, shown as the broken line in Figure 4, remains fixed over time, which results from the private discount rate, ρ, being set equal to the interest rate, r.[3] The constant level of consumption entails the savings rate, set equal to the ratio of the difference between income ($=w_t + r\ S_{t-1}$) and consumption to the income, rising from the negative territory in the early twenties to the peak of 0.58 at age fifty eight and then falling back to 0.53 on the eve of retirement as indicated by the solid line in Figure 5. The worker continues to save until she retires, which is followed by a sharp fall in the savings rate below zero (not shown in Figure 5).

When lifetime (T) is extended by a decade from seventy five to eighty five, the worker needs to save more by consuming less to provide for longer post-retirement life. The lower and flat consumption path is indicated by the dotted line in Figure 4 lying below the broken line. The dotted line in Figure 5 represents the higher savings ratio necessitated by the longer lifetime. The increase in lifetime by a decade raises the savings rate by 18% points, which is the average gap between the dotted and solid lines in Figure 5.

[3] When $r > \rho$, equilibrium consumption path slopes upwards, vice versa.

Life expectancy rose from 75 to 85 years, and old age dependency rising from 5% to 15% from 1989-2015, when private savings ratio fell from 31% to 28% with (Figure 3). Other things being equal, this implies that the ten-year increase in life expectancy associated with the ten per cent points increase in old dependency lowered the private savings rate by 21% points, which is the gap between the estimated increase in the savings ratio caused by the increase in lifetime by ten years, 18%, and the observed change in the savings ratio, -3%. From 1989-2015, other thing of course did not remain equal, and longevity does not necessarily imply a longer life span that needs to be paid for by a larger amount of savings. For one thing, the increase in life expectancy is likely to be associated with the improvement in health, which may allow or prompt individuals to postpone retirement. In addition, if the development of better techniques dealing with old age disorder reduces the uncertainty of lifetime, savings for precautionary purposes may decline (Fisher(1930); Yaari(1965)).

Did Longevity Increase the Savings of Working Age Population?

Whether the improvement in survival probability of the elderly boosts or depresses the savings by working age population is indeterminate in a more general framework of analysis than the textbook version of the life cycle theory, hence remains to be tested empirically. To assess the impact of old age mortality on savings, this section analyzes the micro panel data collected by the Survey on Financial Welfare of Households (known as *Kagye gŭmyungbokchi josa*) carried out by the National Statistical Office of South Korea from 2012-16.

In 2012, the public agency launched the Survey selecting 19,744 households to track the changes occurring in their incomes, assets, and liabilities over the ensuing years. From 2013-14, a minority of the households exited the sample, attrition, which was not fully recouped by the increase occurring in 2015 and 2016.[4] The total number of households in the dataset spanning from is 29,292, which indicates that the number of household shifted 2012-16, not only because attribution and buildup of the 2012 sample occurred, but also because extra households were added in the post-2012 surveys.

Not being one of the questions asked by surveyors, the amount of savings was derived as the changes in net assets. The savings ratio was then calculated by dividing the savings thus inferred with "equalized disposable income," defined as market income plus net public

[4] The sample size shifted to 18,594 in 2013, 17,863 in 2014, 18,031 in 2015, and 18,273 in 2016.

transfer, including taxation, pension payments, and welfare incomes. The average of household savings ratio based on the microdata from 2012-16 was 9.2%, which is somewhat higher than the aggregate household savings ratio as indicated by the national accounts over the five years, 7.1%. From 2012-16, the two distinct estimates of savings ratio varied in the same direction, but the savings ratio as calculated from the survey data fluctuated far more widely than the household savings ratio indicated by the national accounts. The savings ratio based on the micro panel data increased from -60.0% in 2013 to 26.8% in 2014, to 54.1% in 2015, and then fell to 33.0% in 2016. The household savings ratios calculated using the aggregate time series in the four years were 6.3%, 7.3%, 8.4%, 8.3%.

Highly concentrated between minus and plus one, the 62,982 observations on the savings ratios of different households as derived from the micro data from 2012-16 are extremely diffuse, ranging from -3,467 to 4,049. The wide dispersion is attributable primarily to changes in net assets caused by bequest and inheritance. In addition, house price volatility may also explain why the savings ratio is scattered far and wide. To exclude the instances of the value of individuals' net assets surging and plunging due to asset price changes and intergenerational transfers, the estimation was carried out by including households with savings ratio lower than -2 or higher than 2 only.

[Discuss attrition bias: why is the panel dataset unbalanced? Need to compare the estimation outcomes using balanced and unbalanced panel]

Following Deaton and Paxon(2000), I regressed the annual changes in net assets as divided by equalized income on dummies representing 1) survey years, 2) ages, and 3) birth years of household heads.[5] Households headed by persons younger than twenty or older than 65 were excluded, because the number of observations outside the range were not sufficiently large to allow meaningful inference. Birth years ran from 1924-1990, again leaving out earlier and more recent cohorts providing only a small number of observations.

Figure 6 Age Effect on Savings

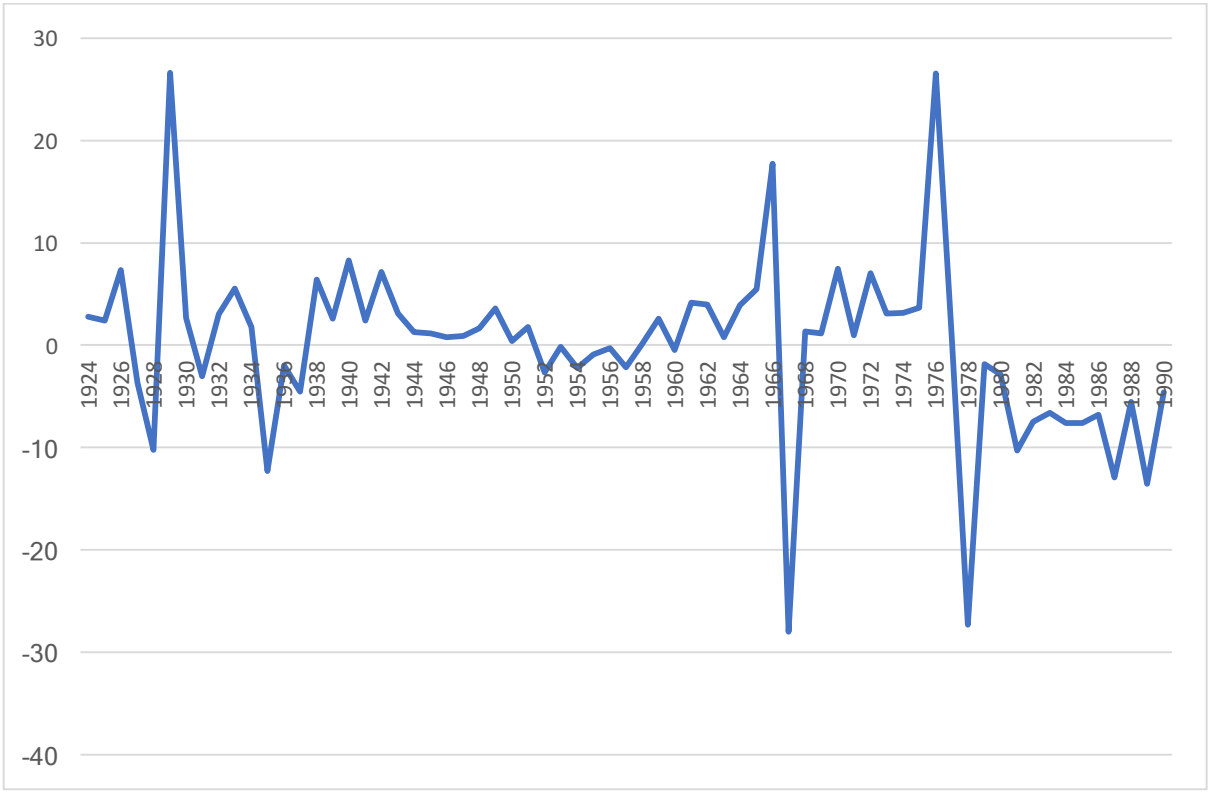
[5] Cross-section fixed effects are also taken into account.

Source: author's calculation; see text.

Note: horizontal axis measures age at the time of survey.

Figure 6 presents the coefficient estimates of the age dummies, which is consistent with the life cycle model of savings in the sense that the savings ratio initially rises and then declines with age. The age profile however has double, rather than single, humps, one peaking in the late twenties followed by the other having a peak in the late fifties. A similar pattern has been found by Park and Rhee(2005: 408, Figure 7)'s analysis of the micro data generated by the South Korean survey on household incomes and expenditures from 1982-99 as well as by Takayama and Kitamura(1994) and by Deaton and Paxon(2000)'s investigation using the Japanese and Taiwanese micro data, respectively. In Cha(2016)'s interpretation, the decline in the age effect from the late twenties to the early fifties in South Korea was caused by the rise in spending for education.

Figure 7 Cohort Effect on Savings Rate



Source: author's calculation; see text.

Note: the horizontal axis indicates the birth year of household heads.

Figure 7 shows the cohort effects on household savings as estimated using the micro panel data from 2012-16. Displaying considerable volatility, it remained trendless until the late 1970s, when it declined substantially. This differs radically from Park and Rhee(2005: 408, Figure 6)'s finding from the analysis using the micro data generated by the Survey on Household Income and Expenditure from 1982-99, which indicated that younger cohorts tended to save more than those born earlier. Also reporting a similar trend in the cohort effect estimated using the Taiwanese survey data from 1976-90, Deaton (1997: 350) observed that the rising cohort effects over time leads one to "the uninformative conclusion that, for some unknown and unmodeled reason, saving rates went up."

The despairing remark may be premature, in the sense that the estimated cohort effect can be put under further scrutiny. For instance, given the dependence of savings on life time wealth rather than current income, it may also reflect ever greater optimism held by successive generations of Taiwanese on forthcoming income growth (Fry and Mason(1982)). The rising trend can also be a consequence of increasing longevity leading younger population to save a larger part of their income for old age security (Lee, Mason, and Miller(2000); Bloom, Canning, and Graham(2003)).

Table 1 Determinants of Cohort Effect on Savings

	Dependent Variable: Cohort Effect on Savings			
	(1)	(2)	(3)	(4)
Old age mortality observed at age 10 (A)	-4090.49***	-3639.1**	-3572.29**	-3920.91***
	(1427.35)	(1475.22)	(1493.64)	(980.24)
(A)*pre-1970 dummy	4177.62***	3591.52**	3513.71**	4275.8***
	(1453.57)	(1503)	(1518.5)	(1018.33)
Income growth observed at age 10-14	-3.92**	93.95*	101.88**	229.68***
	(1.87)	(47.01)	(47.93)	(27.88)
Post-colonial dummy		6.27**	-6.49**	-13.21***
		(2.46)	(2.64)	(2.25)
National pension			-5.34***	-1.51
			(1.98)	(2.14)
Welfare spending/GDP (B)				186.33**
				(71.85)
(B)*post-colonial dummy				-226055.2**
				(93205.86)
Constant	2.22	-7.12*	-0.93	-4.14***
	(1.34)	(3.57)	(1.59)	(1.28)
No. of obs.	67	60	60	43
R-squared	0.16	0.25	0.29	0.49
F-statistic	4.1	4.66	4.42	4.22
D.W.	2.08	2	2.12	2.65

Source: author's calculation; see text.

Table 1 presents the outcome of regressing the cohort effect on the savings ratio estimated using the micro panel data from 2012-16 on shocks shifting the age profile of savings ratio, including income growth and old age mortality. The causal variable of interest, old age mortality, is measured by the probability of dying from 65-79 observed at the age of ten, a choice, which was motivated growing literature indicating that savings and investment behavior in adulthood depends on earlier observations on macroeconomic performance, such as the Great Depression.[6] It also enters the right-hand side together with the dummy variable indicating pre-1970 years to control for the seeming break in the time series of age specific mortality rate occurring between 1966 and 1970 as seen in Figure 2. The discontinuity suggests that the pre-1970 values (derived by Kwon(1977) using colonial and post-colonial census results) and the values from 1970 on (estimated by the National Statistical Office of South Korea) are not entirely consistent.

As seen in column (1), the effect of old age mortality is significantly negative, indicating that old age survival chance as observed by household heads in adolescence encouraged them

[6] See the literature survey in McGuire(2017).

save more. The coefficient estimate associated with the product of old age mortality and pre-1970 dummy was significant and positive. This result may be interpreted as indicating that in the early stage of mortality transition, 1925-66, old age mortality served as a proxy for infant mortality, which helped parents save more by reducing the number of children to be raised. Adding the average of the annual per capita output growth taking place when each cohort reached age 10-14, a measure of the lifetime wealth, on the right-hand side reduced the magnitude of the negative impact of old age mortality, which however remained statistically significant (column (2)). The average of the per capita output growth as observed by household heads in their early teens encouraged savings, a result, which is consistent with Fry and Mason(1982) variable growth model of life-cycle savings. The negative impact of old age mortality persisted when the effect of the introduction of the limited scheme of national pension in 1988 and its subsequent extension was controlled for (column (3)).[7]
As the life cycle theory predicts, pension incomes in the future will be cancelled out by the reduction in current savings. However, mandatory pension programs have been introduced in both developed and developing parts of the world with a view to increasing savings, and the public intervention was justified by altruism, capital market imperfection, and financial illiteracy.[8] Inexplicable either in terms of one of the three reasons or by the life cycle theory, the negative coefficient estimate of the enforcement of national pension system in column (3) is attributable to the way how the savings ratio was derived. The savings ratio, set equal to the ratio of the annual change in net assets to "equalized disposable income," will decline with the introduction of pension scheme, because pension payments are excluded from the numerator, and because pension incomes are included in the denominator.

[7] National pension system was first introduced into South Korea in 1988 for work places hiring more than nine employees to be expanded in 1994 to include smaller businesses employing more than five and less than ten workers, and further widened in 2002 to include even smaller workshops. To measure the impact of the pension system on household savings, an integer variable was created, setting it equal to zero up to 1987, to one from 1988-93, to two from 1994-2001, and, finally, to three from 2002.

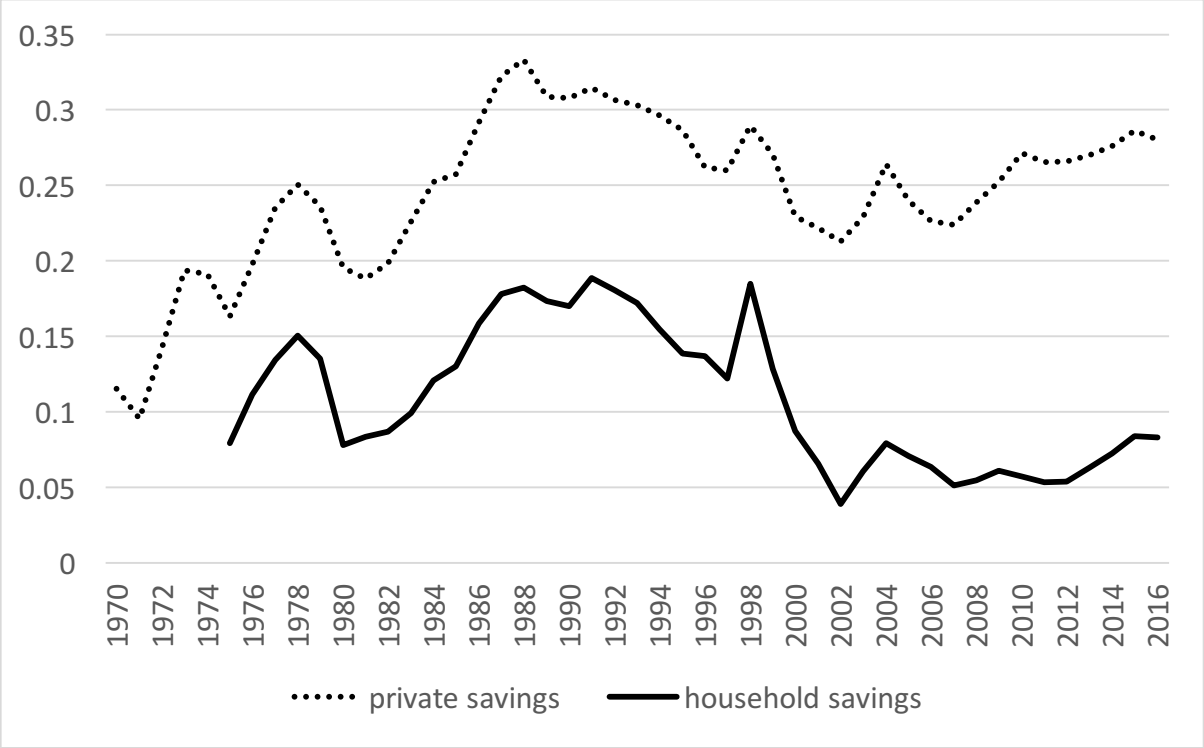
[8] On the effects of intergenerational altruism, capital market imperfections, and financial illiteracy on savings, see Barro(1978), Diamond and Hausman (1984), and Bernheim(1994), respectively.

Finally, in columns (4) is further added welfare spending as share of nominal GDP on the right-hand side, which marginally affected the estimated impact of old age mortality. The definition of welfare spending differed in colonial and South Korea, a gap, which is taken into account by the product term of post-colonial dummy and the ratio of welfare spending to GDP. While theoretically the availability of social welfare reduces precautionary savings, the coefficient estimates of welfare spending over the entire period was significantly positive. Note however that the favorable effect was outweighed by the adverse impact of the social spending in South Korea. Controlling for the impact of welfare spending led to the disappearance of the statistical significance of the adverse impact of public pensions, which suggests that the negative coefficient associated with pension in the under-specified equation in (3) likely picked up the impact of the widening social safety net occurring in tandem with the consolidation of the national pension system.

Did Longevity Boost Savings Enough to Outweigh Its Dependency Effect?

Was the stimulus given by longevity to household savings large enough to offset the decline caused by rising old age dependency? To answer this question, we regress the private savings ratio from 1925-2015 on old age mortality and dependency as well as on other key determinants of private savings, including per capita output growth and real interest rate.

Figure 8 Private and Household Savings Ratios



Source: kosis.kr

The dependent variable in the time series dataset, the private savings ratio, is defined as the aggregate saving ratio minus public savings ratio, hence includes corporate as well as household savings. As seen in Figure 8, from 1975 on, both the secular trend and shorter run fluctuations in the national savings rate was closely paralleled by household, rather than by corporate, savings rate, although corporate savings, indicated by the distance between the dotted and solid lines in Figure 8 accounted for an increasingly large part of the private savings over time.

Right-hand side variables include the probability of dying from age 65-79, per capita output growth and the real interest rate, which are lagged by one year. During the decades of the South Korean high growth, banks were commanded by policymakers to provide credit at costs well below the equilibrium rate of interest rate to firms selected to promote export promotion and import substitution.[9] The financial repression drove the less privileged individuals and companies out of the regulated into the non-regulated, i.e. non-bank, part of the financial system (known as the curb market) to seek credit. In the early 1960s huge interest gaps prevailed between the two sectors of the financial system, with the equilibrium interest rate being more closely followed by the curb market than by bank lending rate. Marginal productivity of capital trended downwards from 1960-90 tracking the real interest rate prevailing in the curb market than in the banking system (Cho(2015: 69, Figure 5.3)). Although financial repression was not implemented in colonial Korea, substantial gaps persisted between moneylender and bank lending rates, which reflected higher default risk associated with lending to household and small businesses, rather than public intervention in the capital market. Again marginal product of capital bore close resemblance to moneylender than to bank lending rates in colonial Korea (Cha(2000)). Hence, the real interest rate was set equal to the money lender rate in colonial and the curb market rate in South Korea minus the growth of GDP deflator.[10]

[9] On the financial repression and the role of curb market in South Korea, see Cole and Park(1983: chapters 4 and 5) and Roh(1994: 170-3).

[10] From 1992 on, when observation on the curb rate is unavailable, I set the curb rate equal to commercial bond rate, because the premium curb rate commanded over commercial bond rate had virtually vanished by the early 1990s. See Chŏng(1996: 187).

The interest rate gap between regulated and unregulated parts of the capital market was on the decline in both colonial and South Korea, testifying to the financial development occurring in the past century. As the financial repression was relaxed in the 1960s and 1980s, the interest rate gap contracted as a matter of trend. In an attempt to liberalize the financial market, the government raised the interest rate on time deposits from 15% to 30% in 1965, lifting bank lending rate as well, which resulted in a sharp increase in time deposits with banks (Cole and Park(1983: 198, 199)). Financial liberalization was carried out on a more sustained basis in the 1980s, which culminated in the abolition of ceilings on most lending rates in December 1988 (Roh(1994: 160)). The declining trend in the interest rate gap was interrupted in the 1970s, when import substitution industrialization (known as the Heavy and Chemical Industrialization Drive) was implemented.[11] In colonial Korea, moneylender and bank lending rates narrowed from 24% points in 1925 to 22% points in 1938, and moneylenders' share in total credit supply nearly halved from 8.2% to 4.5% from 1927-38, which suggest improving access to the banking system given for the more risky type of borrowers (Bae(2002: 225-227)). The gap in the interest rates charged by non-banking institutions and banks are included in the right-hand side as a measure of financial development.

Table 2 Effect of Old Age Mortality on Private Savings Rate, 1925-2015

A. Ordinary least squares results

	Dependent Variable: Private Savings Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
Old age mortality (A)	-2.45**	-1.83	-2.97**	-3.89*	-3.86**	-4.25**
	(1.17)	(1.11)	(1.11)	(2.06)	(1.84)	(1.87)
(A)*Pre-1970 dummy	0.48	2.4	3.42	0.58	0.79	14.68***
	(1.56)	(2.21)	(8.07)	(13.48)	(12.53)	(3.92)
Old age dependency(-1)	-7.31***	-4.24*	-1.36	-1.98	-1.97	-0.98
	(1.57)	(2.51)	(1.67)	(1.6)	(1.42)	(1.34)
Income growth(-1)		-0.35**	-0.37**	-0.29*	-0.29*	-0.21*
		(0.16)	(0.16)	(0.14)	(0.16)	(0.11)
Real interest rate(-1)			0.09***	0.05	0.04	-0.01
			(0.02)	(0.03)	(0.04)	(0.02)
Interest rate gap(-1)			-0.06	-0.12	-0.12	-0.21***
			(0.09)	(0.08)	(0.08)	(0.05)
Colonial dummy	0.01***	-0.002	-0.03***	-0.02**	-0.02*	-0.001
	(0.004)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)

[11] Roh(1994: 160) describes the more sustained measures of financial liberalization taken in the 1980s, which culminated in the abolition of ceilings on most lending rates in December 1988.

				0.24	0.23	0.09
Foreign savings(-1)				(0.16)	(0.17)	(0.12)
				-0.97***	-0.98***	-1.02***
Public savings				(0.32)	(0.29)	(0.29)
					-0.002	-0.02***
Pension					(0.02)	(0.004)
						559.85**
Welfare spending (B)						(253.94)
						-578.68**
(B)*Colonial dummy						(254.22)
	0.001	0.02*	0.01	0.01	0.01	0.03***
Constant	(0.004)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
No. of obs.	71	71	59	59	59	59
R-squared	0.05	0.18	0.17	0.25	0.25	0.51
F-statistic	0.94	2.89	1.47	1.85	1.63	3.93
DW	2.56	2.26	2.18	2.09	2.1	1.97

B. Two-stage least squares results

	Dependent Variable: Private Savings Rate				
	(1)	(2)	(3)	(4)	(5)
	-8.05	3.95	-2.76	-6.16***	-6.01***
Old age mortality (A)	(13.15)	(25.58)	(10.24)	(1.88)	(2.11)
	-4.54	55.28	18.15	-14.16	16.18
(A)*Pre-1970 dummy	(16.59)	(281.6)	(74.31)	(24.92)	(24.11)
	-20.42	-11.18	-7.43	-4.45	0.24
Old age dependency(-1)	(27.1)	(54.11)	(40.54)	(20.02)	(3.06)
	5.78	7.1	3.92	2.08	0.2
Income growth	(10.42)	(24.36)	(9.79)	(4.65)	(1.02)
		-0.52	-0.24	0.09	0.07
Real interest rate		(2.35)	(0.83)	(0.27)	(0.05)
		-4.67	-2.15	-0.88	0.56
Interest rate gap		(16.08)	(6.6)	(3.01)	(0.83)
	0.16	0.36	0.19	0.1	0.01
Colonial dummy	(0.28)	(1.35)	(0.5)	(0.23)	(0.06)
			0.06	0.39*	0.04
Foreign savings(-1)			(0.93)	(0.2)	(0.24)
			-5.4	-3.63	-1.49
Public savings			(11.78)	(4.31)	(1.03)
				0.07	-0.01
Pension				(0.12)	(0.05)
					-37.73
Welfare spending (B)					(29.37)
					578.67
(B)*Colonial dummy					(351.98)
	-0.31	-0.39	-0.22	-0.19	-0.02
Constant	(0.56)	(1.23)	(0.5)	(0.3)	(0.05)
No. of obs.	71	58	58	58	58
R-squared	-26.04	-32.39	-7.01	-0.75	0.69
F-statistic	0.09	0.04	0.18	0.73	8.2
DW	1.93	2.06	2.19	2.12	1.78

Source: author's calculation; see text.

The regression outcomes are presented as Table 2, which has two panels. Panel A reports ordinary least squares results using per capita output growth and interest rates lagged by one year as regressors, and two stage least squares results are presented in panel B, which were obtained instrumenting per capita output growth and interest rates in year *t* with their values in in year *t-1*.

Column (1) of panel A in Table 2 begins by regressing private savings ratio on 1) old age mortality as measured by the probability of dying from 65-79 and 2) old age dependency as well as on 3) a dummy variable indicating colonial years, and 4) the product of the pre-1970 dummy and the old age mortality. The colonial dummy was included to capture the effects of the split into two Koreas in 1945 and the inconsistency between pre- and post-1945 interest rates, which arises primarily because financial repression was not implemented in pre-1941 Korea. The coefficient estimates associated with old age mortality and dependency were both significant and negative, suggesting the presence of two opposing effects of increasing longevity on savings.

Adding lagged per capita output growth on the right-hand side (column (2)) led the two negative coefficients to be less precisely estimated with the level of significance falling to 11% for old age mortality and to 10% for old age dependency.

The real rate of interest and the interest rate gap between the unregulated and regulated sectors are further included as regressors in column (3). As a result of the augmentation, the old age dependency lost statistical significance, the coefficient estimate of old age mortality became highly significant, and its magnitude increased substantially. The real interest rate stimulated savings, which did not depend significantly on the financial development occurring in colonial and South Korea as measured by the interest rate gap. This result likely represents two mutually offsetting impacts of financial development on savings, which included stimulus given to savings by higher bank deposit rates and diminishing liquidity constraint on consumption.[12]

Column (4) has foreign and public savings added as controls on the right-hand side. While the inflow of foreign savings hardly affected domestic savings, public savings crowded out private savings nearly on point-for-point basis. Possibly evidence supporting the Ricardian equivalence hypothesis, this result more likely arose, because pension payments were

[12] Williamson(1979) attributed the low savings rate in South Korea from 1962-76 to the bank deposit rates, which had been kept at an artificially low levels. See Cha(1996) for evidence of liquidity constraint depressing consumption.

classified under the public, rather than private, savings in the current system of the South Korean national accounts. Controlling for both foreign and public savings substantially increased the coefficient estimate of old age mortality, but led it to be identified less sharply. As a further control, column (5) has public pension scheme on the right-hand side, which changed the estimated effect of old age mortality marginally but raised the level of significance back to 5%. The coefficient estimate of the public pension was statistically insignificant. Finally, controlling for the negative and significant effect of welfare spending in column (6) increased the estimated negative impact of old age mortality, which remained significant at 5% level. As in Table 1, welfare spending boosted savings, although its impact on savings was adverse in colonial Korea. Note that the coefficient estimate is statistically significant in column (6).

Overall, panel A of Table 2 shows that improving survival chances of the elderly raised the aggregate savings ratio, while the effect of old age dependency was statistically insignificant. Income growth depressed private savings, which was hardly affected by the real interest. Empirical evidence marshalled in different parts of the world tends to indicate that the effect of interest rate on savings is insignificant, which is consistent with that higher interest could raise or lower savings rate, depending upon whether income or substitution or wealth effect of the interest rate change prevails.[13] Consistent neither with habit formation nor with precautionary motives story nor with the variable rate-of-growth model of life-cycle savings, the negative and significant coefficient estimate of income growth may be rationalized by the permanent income hypothesis, whereby higher income growth may cause individuals to expect higher income levels to prevail in the future, leading them to reduce savings to finance future consumption.[14]

Columns (1)-(5) of panel B present the two stage least squares estimation of the specification in columns (2)-(6) of panel A. The outcomes in columns (1)-(3) include not a single coefficient estimate that is statistically significant, which are associated with correspondingly low F-statistics. Adding public pension as a further control in columns (4) and (5) resulted in sharp increases in R-squared, leading to the negative coefficients of old age mortality to acquire statistical significance 1% level, which were about one and half times as large as the

[13] See Giovannini(1985); Schmidt-Hebbel, Webb, and Corsetti (1992).

[14] Existing studies, such as Carroll and Weil(1994), Collins(1994), and Edwards(1995), tend to report positive coefficient estimate of income growth.

OLS estimates in columns (5) and (6) of panel A. Other coefficient estimates remained mostly insignificantly different from zero.

The results in the two panels of Table 2 represent mixed evidence on the savings consequences of income growth, the interest rate, pension program, and welfare spending. In contrast, the impact of old age survival probability on savings remains robustly and significantly positive, and the coefficient estimate of old age dependency was mostly insignificantly different from zero, which leads to the conclusion that longevity boosted, rather than depressed savings in Korea.

Conclusions

This paper highlighted two offsetting impacts of ageing on the aggregate savings, including the adverse impact of rising old age dependency and the savings incentive given by the need to provide for longer life expectancy. As the analysis of the South Korean micro panel data collected from 2012-16 revealed, the old age mortality as observed by different birth cohorts in their early teens had discouraged savings when they grew up to earn wage incomes, which is consistent with the prediction of life cycle theory. The boost to savings as motivated by old age security was large enough to more than balance the adverse impact of the increasing population share of dissevers caused by population ageing. As the ordinary and two-stage least squares regressions using the time series data spanning both pre- and post-1945 era indicated, the effect of old age survival probability on the private savings ratio was positive, while old age dependency hardly mattered for the private savings ratio. These findings suggest that inferences on the savings consequences of demographic change based solely on the age structure of population and lacking microeconomic foundation may be misleading.

Appendix: Summary Statistics

	Order of Integration	Mean	Standard Deviation
Estimated cohort effect	0	0.0021	8.6207
Foreign savings/GDP	0	0.0105	0.0443
Interest rate gap	1	-0.0064	0.0294
Old age dependency	2	0.0038	0.0594
Per capita output growth	0	0.0405	0.0606
Private savings ratio	1	0.003	0.0536
Probability of dying from 65-79	2	-7.54E-05	0.0019
Public savings/GDP	1	0.0006	0.0093
Real interest rate	0	0.208	0.169
Welfare spending/GDP	2	-7.89E-05	0.0021

Note: summary statistics were calculated after differencing required to obtain stationarity.

References

Bae, Y. 2002, *Han'gukkŭmyungsa,* Ch'ungbuk University Press, Ch'ungju.

Barro, R.J. 1978, *The Impact of Social Security on Private Saving,* American Enterprise Institute, Washington.

Bernheim, D. 1994, "Personal Saving, Information, and Economic Literacy: New Directions for Public Policy", *Tax Policy for Economic Growth in the 1990s*, ed. American Council for Capital Formation, Washington D.C.

Bloom, D.E., Canning, D. & Graham, B. 2003, "Longevity and Life-cycle Savings*", *Scandinavian Journal of Economics,* vol. 105, no. 3, pp. 319-338.

Carroll, C.D. & Weil, D.N. 1994, "Saving and growth: a reinterpretation", *Carnegie-Rochester Conference Series on Public Policy*Elsevier, , pp. 133.

Cha, E.Y. 1996, "Chŏch'ukhaengdonggwa yudongsŏngjeyak", *Kyŏngjehagyŏn'gu,* vol. 44, no. 4, pp. 27-48.

Cha, M.S. 2016, "Untangling the South Korean Growth Miracle", *Keynote Speech Delivered at the 5th Asian Historical Economics Congress, Seoul, transcript available for download at http://myungsoocha.wordpress.com*, 2016.

Cha, M.S. 2000, "The Colonial Origins of Korea's Market Economy" in *Asia Pacific Dynamism, 1550-2000*, eds. A.J.H. Latham & H. Kawakatsu, Routledge, London, pp. 86-103.

Cho, D. 2015, *Growth, Crisis, and the Korean Economy,* Routledge, London.

Coale, A.J. & Hoover, E.M. 1958, *Population growth and economic development in low-income countries: a case study of India's prospects,* Princeton University Press, Princeton.

Cole, D.C. & Park, Y.C. 1983, *Financial development in Korea, 1945-1978,* Harvard University Asia Center, Cambridge, Mass.

Deaton, A. 1997, *The analysis of household surveys: a microeconometric approach to development policy,* World Bank Publications.

Deaton, A.S. & Paxson, C.H. 2000, "Growth, Demographic Structure, and National Saving in Taiwan", *Population and Development Review,* vol. 26, pp. 141-173.

Diamond, P.A. & Hausman, J.A. 1984, *Individual retirement and savings behavior*.

Disney, R. 1996, "Ageing and Saving", *Fiscal Studies,* vol. 17, no. 2, pp. 83-101.

Edwards, S. 1995, "Why are saving rates so different across countries?: An international comparative analysis", *NBER Working Paper no 5097,* .

Feldstein, M. 1979, "The Effect of Social Security on Saving", *NBER Working Paper,* vol. 334.

Feng, J., He, L. & Sato, H. 2011, "Public pension and household saving: Evidence from urban China", *Journal of Comparative Economics,* vol. 39, no. 4, pp. 470-485.

Fisher, I. 1930, *The Theory of Interest,* Macmillan, New York.

Fogel, R.W. 1997, "Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Process on the Making of Economic Policy", *American Economic Review,* vol. 84, pp. 369-395.

Fogel, R.W. 1997, "Chapter 9 New findings on secular trends in nutrition and mortality: Some implications for population theory" in *Handbook of Population and Family Economics, vol. 1A*, eds. M.R. Rosenzweig & O. Stark, Elsevier, , pp. 433-481.

Fry, M.J. & Mason, A. 1982, "The Variable Rate of Growth Effect in the Life-Cycle Saving Models", *Economic Inquiry XX,* , pp. 426-442.

Giovannini, A. 1985, "Saving and the real interest rate in LDCs", *Journal of Development Economics,* vol. 18, no. 2-3, pp. 197-217.

Higgins, M. & Williamson, J.G. 1997, "Age Structure Dynamics in Asia and Dependence on Foreign Capital", *Population and Development Review,* vol. 23, pp. 261-293.

Kang, K. 1994, "Why Did Koreans Save So "Little" and Why Do They Now Save So "Much"?", *International Economic Journal,* vol. 8, no. 4, pp. 99-111.

Kim, N.N. (ed) 2012, *Han'gugŭi changgit'onggye [Historical Statistics of Korea]*, Seoul National University Press, Seoul.

Kwon, T.H. 1977, *Demography of Korea: Population Change and its Components, 1925-66,* Seoul National University Press, Seoul.

Lee, R., Mason, A. & Miller, T. 2000, "Life Cycle Saving and the Demographic Transition: The Case of Taiwan", *Population and Development Review,* vol. 26, pp. 194-219.

McGuire, Erin. 2017, "Estimating the Impact of Local Conditions on Asset Preference in Adulthood" , paper presented at the 8th World Congress of Cliometrics, Strasbourg.

Park, D. & Rhee, C. 2005, "Saving, Growth and Demographic Change in Korea", *Journal of Japanese and International Economies,* vol. 19, pp. 394-413.

Roh, S. 1994, "Korean Monetary Policy" in *Macroeconomic Policy and Adjustment in Korea 1970-1990*, eds. S. Haggard, R.N. Cooper, S. Collins, C. Kim & S. Roh, Harvard University Press, Cambridge, Mass.

Schmidt-Hebbel, K., Webb, S.B. & Corsetti, G. 1992, "Household saving in developing countries: first cross-country evidence", *The World Bank Economic Review,* vol. 6, no. 3, pp. 529-547.

Takayama, N. & Kitamura, Y. 1994, "Household saving behavior in Japan" in *International Comparisons of Household Saving* University of Chicago Press, , pp. 125-168.

Williamson, J.G. 1979, "Why do Koreans save 'so little'?", *Journal of Development Economics,* vol. 6, no. 3, pp. 343-362.

Yaari, M.E. 1965, "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer", *The Review of Economic Studies,* vol. 32, no. 2, pp. 137-150.