Demographic change and the saving rate of Japanese households: the aggregate effect is almost nil

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Abstract

In this paper, I examined how much changes in demographic structure might account for the sharp decline in the saving rate of Japanese households since the early 1990s. Using household data from the National Survey of Family Income and Expenditure, I estimated age-saving profiles for five major household types (singles, couples with children, couples without children, single parents with children, and multi-generation households). After applying these estimates to the actual age structure of Japanese households between 1990 and 2005, I found that changes in demographic structure had only modest effects on the saving rate of Japanese households. I also predicted the future contribution of demographic structure on the saving rate, using projections of Japan's household structure by age in 2010–2030. The projected effect of population structure reduced the household saving rate, but the effect was remarkably small, by just 0.01 percentage points from 2010 to 2030. Overall, the micro-level evidence in this paper does not support the conventional view that the recent decline in the saving rate of Japanese households is mainly due to the effect of population aging.

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1 Introduction

In this paper I present evidence from Japanese micro data that population aging could have a negligible impact on the household saving rate, both in the past and in the future. This finding runs against the conventional view that the rapid drop in Japan's saving rate, from around 15 percent in the early 1990s to almost zero in recent years (Figure 1), mainly reflects the effect of population aging (Horioka, 2008; Hoshi and Kashyap, 2011). The link between population aging and declining saving rate stems from the life-cycle hypothesis (LCH) of Modigliani and Brumberg (1954). The LCH postulates a humped-shaped saving profile over the life cycle, with a principal claim that savings become negative for aged and retired individuals (Horioka, 2006). Due to rapid population aging, the share of aged and retired individuals has increased substantially in Japan, while the share of working-age population has declined. If age-saving profiles are sufficiently humped-shaped over the life cycle, the aggregate effect of these two secular trends in Japan's population structure should reduce the saving rate of Japanese households.

The importance of demographic structure for explaining Japanese household savings was pointed by Horioka (1991), while Dekle (2005) and Koga (2006) provided recent empirical support that Japan's demographic structure had a significant effect on the decline in household saving rate since the early 1990s. But the evidence in these studies was based on aggregate data for household saving rate and the share of major age groups. Such macro-level data are well-known to have serious limitations. First, demographic trends are typically slow, and may pick up the effect of *other* slowly changing trends, such as a secular trend that makes personal saving less important to households, with the effect similar across different age groups (Bosworth *et al.*, 1991, p. 197). Second, the slow pace of the population aging does not fit well with nonlinear changes in the saving rate of Japanese households, with a particularly rapid declines in some years, and no change at all in other years (Iwaisako and Okada, 2010).

Rather than using macro data, a number of studies examined the link between population structure and household saving with micro-level data that measure saving decisions of specific households. With micro data, it is possible to account for various household characteristics that are important for explaining differences in saving decisions. In addition, micro data allow controlling for secular trends in the saving rate at the macro level (by using time dummy variables for general period effects). In contrast, the aggregate data could misinterpret these general period effects for the contribution of demographic trends.

Curiously, the micro studies have repeatedly reached the opposite conclusion to studies with aggregate data, with a common finding that changes in the population structure have very small effects on household savings. Weil (1994) provides a comprehensive summary of earlier micro-level studies. More recent micro-level evidence for small demographic effects was reported by Parker (2000) for the United States, Jappelli and Pagano (1999)), Baldini and Mazzaferro (2000) for Italy, Demery and Duck (2006) for the United Kingdom, and Park and Rhee (2005) for South Korea. As shown in Figure 1, all these countries experienced significant decline in household saving rates in recent years, yet changes in the demographic structure of these countries had very minor estimated effect. A much more significant effect was from uniform changes across different age groups, presumably reflecting a common macroeconomic effect on the saving rate, rather than changes in the share of different age groups with different propensities to save.

Compared with other countries, micro-level evidence for Japanese households remains scant. One of the earliest study was done by Bosworth *et al.* (1991), who used data from the Family Saving Survey between 1970 and 1989. The study concluded that "differences in saving rates among age groups are simply not large enough to generate major demographic effects on the aggregate saving rate" (p. 220-221). In addition, the study examined a long-term correlation between the population aging in Japan and the decline in household saving rate, but concluded that "the relationship does not appear causal" (p. 221).

Subsequently, Ito and Tsuri (2006) calculated the expected contribution of demographic factors to Japanese saving rate from 2000 to 2050. Saving rates for different ages were based on the National Survey of Family Income and Expenditure for 1999. Since the original data were available for households only, the paper used a special set of equivalence scales to derive individual-based saving rates. These saving rates were then applied to mid-point population projections from the National Institute of Population and Social Security Research (IPSS). The net effect of demographic change was minor, with saving rate declining from around 35 to 32 percent during 2000-2050.

More recently, Iwaisako and Okada (2010) used raw age-saving profiles from the Family Income and Expenditure Survey (FIES) in 1997, and calculated the contribution of demographic change to the declining household saving rate from 1997 to 2008. The paper found that changes in the demographic structure contributed 2.5 percentage points to the decline in the saving rate, with a residual drop by 5.9 percentage points still unexplained (p. 11). Finally, Hoshi and Ito (2012) used the data from the FIES, and calculated average saving rates for different age brackets from 2000 to 2010. Then the study applied these saving rates to mid-point population projections from the IPSS for 2010 to 2050. The net effect of the population aging was estimated to be larger then in conceptually similar study by Ito and Tsuri (2006), with demographic factors reducing the saving rate by around 6 percentage points from 2010 to the end of the 2040s.

The previous micro-level studies for Japan calculated the aggregate effect of demographic structure with only raw saving rates for different age groups, with no adjustments for effects from other determinants of household savings. In contrast, this paper estimates age-saving profiles from a semiparametric model of household saving that controls not only for the age effect, but also for other factors of household saving, such as differences across birth cohorts, aggregate period effects that that are the same across different ages and birth cohorts, and household characteristics that may be important for explaining differences in saving behavior.

Compared with previous studies, the paper makes three major contributions. First, as already mentioned, instead of using unadjusted age-saving propensities, the paper used regression-based estimates for age, cohort and period effects, and identified separately the contribution of each of these effects on the past and future changes in household saving rate.

Second, the paper dealt with a possible heterogeneity in the saving behavior in different family types. The LCH focuses mostly on the saving behavior of individuals, rather than households, who save in preparation for old age. So the LCH largely neglects the impact of family structure, as well as children, on saving behavior. In the extreme case, the stripped-down version of the LCH assumes that individuals stay single, and raise no children. In consequence, there is particularly scant empirical evidence on whether different family arrangements have effect on household saving profiles over the life cycle[1]. Paxson (1996), Attanasio *et al.* (1999) and Fernández-Villaverde and Krueger (2007) previously demonstrated that changes in family structure have large effects on age-saving profiles. However, these studies estimated only linear effects from family structure, with demographic variables (such as the number of adults and children in households) included among linear parametric effects. In contrast, I examined the impact of family structure with a flexible semiparametric model, and estimated age-saving profiles across different family types by nonparametric terms that allow nonlinear effects on savings.

Third, the paper used consistently household weights (rather than the combination of household and population weights) for calculating the aggregate effects on household saving rates. In most previous studies, saving rates were differentiated by the age of household head, but projections of future demographic structure were typically taken from population projections that refer to individuals, rather than households. To get consistency between households and individuals in population structure, the conventional approach needs to make a number of assumptions, including fixed average size of households over time, and a special set of equivalence scales to convert household data to individuals. In contrast, this paper uses the same aggregation structure of households, both at the estimation stage to derive age-saving profiles, and at the aggregation stage to calculate the net effect of demographic change.

To preview major findings, the paper found that different family arrangements have much more complex effects on savings than could be captured by conventional linear specifications of demographic effects. However, these differences in age-saving profiles were insufficient to produce a large effect from demographic structure on the saving

[1] Such family arrangements include decisions to live with a partner, or to stay single, and whether to raise children, once again as a couple, or as a single parent.

rate of Japanese households, both in the past, and in the future. Three major findings stand out.

First, the paper found that households without children started to reduce their saving rate much earlier than predicted by the LCH, with the peak saving rate reached as early as in mid-40s. On the other hand, households with children had peak saving rates at an older age, in the late 50s. Evidently, it is the presence of children, and not the prospect of old age that motivates households to maintain high saving rates up to the retirement age.

Second, the paper examined whether the presence of aged *and* retired household members, as emphasized by Horioka (2006), might reduce the overall savings by households. To examine this key prediction of the LCH, I estimated the net effect on household saving rate from aged and retired members, with two groups of households that had such household members. When only one aged and retired household members, the net effect on saving rate was negative and statistically significant. However, the scale of the effect was small, by less than one percentage point. Moreover, with two aged and retired household members, their effect on the saving rate turned insignificant, providing little support to the central implication of the life-cycle hypothesis in Japanese micro data.

Third, when I applied estimated age effects on household savings to to the actual age structure of Japanese households between 1990 and 2005, the past changes in demographic structure had only modest effects on the aggregate saving rate of households, with essentially no net effect over the span from 1990 to 2005. When I predicted the future contribution of demographic structure, using mid-point projections of Japan's household structure by age until 2030, the demographic effect was again negligible, by only 0.1 percentage points from 2010 to 2030. Overall, the micro-level evidence in this paper does not support the conventional view that the recent decline in the saving rate of Japanese households is mainly due to the effect of population aging.

The paper is organized as follows. Section 2 describes the estimation of life-cycle profiles by semiparametric models, and introduces the varying-coefficient model of Hastie and Tibshirani (1993), which was used to specify differentiated age effects on savings. Section 3 outlines main features of semiparametric estimation. Section 4 explains data sources, and describes major adjustments to the original household data. Estimation results are reported in Section 5, while Section 6 offers major conclusions.

2 Model specification

2.1 Basic models of household savings with a single nonparametric effect.

I start with a conventional life-cycle model household consumption, then proceed to a closely-related model of household income, from which it will be trivial to derive a baseline model of household saving. Households are assumed to smooth their consumption over life cycle, and the level of consumption depends on the lifetime stock of household wealth. Specifically, consumption is a fraction of household's lifetime wealth, which depends on the age of household head:

$$c_{i,t} = \delta\left(age_i\right) W_i \exp\left(\varepsilon_{i,t}\right) \tag{1}$$

where $c_{i,t}$ is consumption expenditures of household i at time t, W_i is the total lifetime wealth of household, and $\varepsilon_{i,t}$ is the regression disturbance.

Parameter $\delta\left(age_i\right)$ defines the age profile of consumption, and reflects changing composition of households, and varying needs of household members over the life-cycle. After taking logs of (1), we obtain an additive specification that includes age and wealth effects on consumption. The specification is further extended by a vector of observable variables $z_{i,t}$, which includes demographic effects (namely, the average number of adults and children per household), and other household characteristics, such as region of residence, occupation, education, race, marital status, gender, and similar controls for household head:

$$ln\left(c_{i,t}\right) = \log\left(\delta\left(age_i\right)\right) + \log\left(W_i\right) + \beta' z_{i,t} + \varepsilon_{i,t} \tag{2}$$

The baseline model (2) is specified for individual households, but Japanese household data for this study do not have a panel dimension. So model (2) is re-expressed in terms of groups of households, or household *cohorts*, that can be traced across over time. The household cohorts are identified by the birth year of household head. Let a birth year be denoted by c, so that $c = t - age$, where t is the current year. After averaging (2) across birth cohorts c, we get

$$\log\left(c_{c,t}\right) = \log\left(\delta\left(age_c\right)\right) + \alpha_c + \beta' z_{c,t} + \varepsilon_{c,t} \tag{3}$$

where c identifies a particular birth cohort, and α_c is the average logarithm of lifetime wealth of households belonging to cohort c.

To account for the time variation in household consumption, specification (3) is extended by a set of year dummies D_t for observation years $t = 1, \ldots, T$. In addition, the age effect $\log\left(\delta\left(age_c\right)\right)$ is replaced by a flexible function of age, specified by a set of dummy variables D_a. Similarly, the fixed effect from different birth cohorts α_c is estimated by a matrix D_c with cohort dummies, resulting in the baseline model of household consumption with age, cohort and period effects:

$$\log\left(cons_{c,t}\right) = \alpha'_{a,cons} D_a + \alpha'_{c,cons} D_c + \alpha'_{t,cons} D_t + \beta'_{cons} z_{c,t} + \varepsilon_c \tag{4}$$

Next, I specify regression model for household income, from which it will be trivial to derive a model for household savings. Following Paxson (1996), the life-cycle profile of household income is specified similarly to the consumption model (4):

$$\log\left(inc_{c,t}\right) = \alpha'_{a,inc}D_a + \alpha'_{c,inc}D_c + \alpha'_{t,inc}D_t + \beta'_{inc}z_{c,t} + \varepsilon_c \tag{5}$$

where $inc_{c,t}$ denotes disposable income of households belonging to cohort c at time t.

To obtain the model of household savings, I use the following approximation: when income $inc_{c,t}$ and consumption $cons_{c,t}$ are not much different, $log\left(inc_{c,t}\right) - log\left(cons_{c,t}\right) \approx \frac{inc_{c,t} - cons_{c,t}}{inc_{c,t}}$, which in turn equals to the saving rate $sr_{c,t}$. Thus, by subtracting equation (5) from (4), we obtain the baseline model of household savings:

$$sr_{c,t} = \alpha'_a D_a + \alpha'_c D_c + \alpha'_t D_t + \beta' z_{c,t} + \varepsilon_c \tag{6}$$

with adjustments in model's parameters (for example, $\alpha_a = \alpha_{a,inc} - \alpha_{a,cons}$).

However, this model has a serious limitation: the exact linear relationship among age a, birth cohort c, and current year t (*i.e.*, current year minus age equals the birth year). Due to the exact collinearity, it is not possible to estimate (6) by linear regression estimators, unless some restrictions are introduced in the three interlinked effects.

Fernández-Villaverde and Krueger (2007) proposed to solve the identification problem by replacing age dummies D_a with a smooth nonlinear function of age, which I will denote by $f(a)$. With this substitution, model (6) becomes a semiparametric model with a single nonparametric component $f(a)$, and the parametric part including the rest of explanatory variables (namely, cohort and period dummies D_c and D_t, and other control variables in vector $z_{c,t}$):

$$sr_{c,t} = f(a) + \alpha'_c D_c + \alpha'_t D_t + \beta' z_{c,t} + \varepsilon_c \tag{7}$$

This semiparametric specification imposes only a mild restriction on the age effect $f(a)$, which is assumed to be a smooth function of age. Apart from this restriction, the shape of $f(a)$ is unspecified, and its estimate depends entirely on the data.

In first three models, the nonparametric age effect $f(a)$ is left unchanged, and three alternative specifications for the parametric part are considered. In particular, I examined whether the estimate of nonparametric age effect $f(a)$ would change much with three different parametric specifications in Models 1-3. In Model 1, the parametric part included only cohort and period effects:

$$sr_{i,t} = f(a) + \alpha'_c D_c + \alpha'_t D_t + \varepsilon_{i,t} \tag{8}$$

In Model 2, the parametric part was extended by demographic variables $z_{i,t}^{demogr}$, which included three groups of variables: the number of adults and children, living in household, and the number of aged and retired members of household:

$$sr_{i,t} = f(a) + \alpha_c' D_c + \alpha_t' D_t + \beta' z_{i,t}^{demogr} + \varepsilon_{i,t} \tag{9}$$

Finally, Model 3 included the rest of control variables $z_{i,t}^{other}$, such as the marital status of household head, region of residence, industry of occupation, type of employment contract, and similar controls:

$$sr_{i,t} = f(a) + \alpha_c' D_c + \alpha_t' D_t + \beta' z_{i,t}^{demogr} + \gamma' z_{i,t}^{other} + \varepsilon_{i,t} \tag{10}$$

2.2 Varying-coefficient models of household savings

In Model 4, I retained the parametric part of Model 3, and replaced the nonparametric age effect $f(a)$ with separate age effects on saving for different family types. These differentiated age effects were specified by the varying-coefficient model of Hastie and Tibshirani (1993).

A distinctive feature of the varying-coefficient model is that nonparametric effects interact with categorical variables (such as different family types). Consider a general semiparametric model that has the parametric part $\theta' X$ and a single nonparametric term $f(z)$. Assuming that $\theta' X$ and $f(z)$ are additive effects, the response variable y is specified by $y = \theta' X + f(z) + \varepsilon$, where ε is the conventional error term.

Let d be a dummy variable with two distinct values, d_1 and d_2. In the varying-coefficient model, the shape of nonparametric effect $f(z)$ depends on values of the dummy variable d:

$$y = \theta' X + f(z) d_1 + f(z) d_2 + \varepsilon \tag{11}$$

with $f(z)d_1$ and $f(z)d_2$ denoting two separate estimates of nonparametric effects, depending whether d takes the value d_1 or d_2.

The general specification (11) can be used to derive age effects on savings from different family types. Let households be divided into five family types:

1. single households,
2. couple with no children,
3. couple with children,
4. single parent with children,
5. extended (i.e., non-nuclear) family.

Using this classification, Model 4 was specified with a matrix of dummy variables D_f for five family types, and corresponding differentiated age effects $f(a)_f$:

$$sr_{i,t} = \sum_{f}^{5} f(a)_f D_f + \alpha_c' D_c + \alpha_t' D_t + \beta' z_{i,t}^{demogr} + \gamma' z_{i,t}^{other} + \varepsilon_{i,t} \quad (12)$$

The varying coefficient model (12) essentially introduces heterogeneity in nonparametric age effects, and keeps the same parametric specification for different household types. This allows using the complete data sample, from which we can obtain separate nonparametric estimates of age-saving profiles for different family types.

3 Estimation method

To save space, I will discuss only main issues in estimating semiparametric models in this paper. When estimating semiparametric models with a single nonparametric term $f(a)$, three problems have to be solved:

1. how to represent the smooth function $f(a)$,
2. how to specify a smoothness parameter that controls the trade-off between smoothness and goodness-of-fit in estimated $f(a)$,
3. how to select the smoothness parameter in a data-dependent way.

These three problems are addressed in a library of semiparametric estimators *mgcv*[2] Wood (2012) in statistical package *R* R Development Core Team (2012). First, the *mgcv* library provides a large number of basis functions to approximate the smooth function $f(a)$. Second, the library provides a large number of penalty functions and smoothness parameters, which could control the trade-off between the smoothness and fit in estimated $\hat{f}(a)$. Third, the library provides a data-dependent selection of smoothness parameters. Two alternative approaches are available, either by minimizing the generalized cross validation (*gcv*) statistics (Craven and Wahba, 1979), or by solving a mixed model for variance components that maximizes the restricted maximum likelihood (REML) statistic (Ruppert *et al.*, 2003).

When interpreting the output from the *mgcv* library, one parameter is particularly useful: the estimated number of degrees of freedom for approximating non-parametric terms. Let this parameter be denoted by v. When $v = 1$, this implies that the non-parametric term can be approximated by a single variable with linear effect. On the other hand, higher values of v indicate increasingly complex patterns that require more degrees of freedom.

The upper limit for v is the sample size, but in practice much smaller values are used. The default value of v in the *mgcv* library is 10. But this provides only an initial estimate for v, and the library then estimates a data-dependent value of v, which could be in the range between 1 and the initial choice of v.

[2] The acronym *mgcv* stands for 'modified generalized cross validation'

4 Data

Data for Japanese households were were taken from the National Survey of Family Income and Expenditure (NSFIE) for 1989, 1994, 1999, and 2004. The raw data were provided by the National Statistics Center of Japan, as a random sub-sample with 80 percent of the original sample. Detailed description of the NSFIE is available in Hayashi (1997) and Kitamura *et al.* (2003), and I will provide only information that is relevant for interpreting results in this paper.

A typical wave of the NSFIE collects data from almost 60 thousand households. The survey provides exceptionally detailed information on living conditions of households, including annual income, consumption expenditures of a large number of goods and services, financial assets and liabilities, demographic and employment status of household members, their education level, and many other characteristics.

The random sub-samples with 80 percent of original households included about 3,500 households with single members, and 44,500 households with two and more household members. The combined sample size for 4 waves of NSFIE was 192,599 households, but due to data cleaning, the final sample contained 168,058 households.

In subsequent subsections, I explain definitions of major variables, discuss major data adjustments, and explain in more details the data-cleaning process.

4.1 Variable definitions.

The saving rate was defined as the difference between disposable income and non-durable consumption, normalized by disposable income. Disposable income and non-durable consumption broadly followed definitions in Hayashi (1997).

Specifically, disposable income was the difference between gross income and non-living expenditures, which included taxes and social security contributions. Gross income mainly contained wages, income from assets (such as dividend and interest income), income in kind, and social security benefits. For households that owned housing, gross income also included the imputed rent from owner-occupied housing. Remittances from outside households were not classified as income. Non-living expenditures included taxes (such as income tax, resident tax, and other tax categories) and social security contributions (such as public pension fees, health insurance fees, and the like).

Nondurable consumption was equal to the total consumption expenditures, less expenditures on durable goods. To identify expenditures on durable goods, I used the NSFIE's classification into four expenditure types: durable goods, semi-durable goods, non-durable goods, and services. Then nondurable consumption was calculated by omitting the first category from the total consumption expenditures. Following Hayashi (1997), I included in consumption expenditures the imputed rent of homeowners, and excluded remittances to the outside of households.

4.2 Data adjustments

The NSFIE is conducted during the three-month period from September to November. While data for gross household income cover the whole calendar year, consumption expenditures refer only to the survey period. To remove the impact of seasonal factors, I extrapolated the expenditure data for the full year. Similarly to Hayashi (1997) and Kitamura *et al.* (2003), I calculated seasonal adjustment coefficients for major consumption expenditures, using comparable categories from another household survey in Japan, the Family Income and Expenditure Survey (FIES). Unlike the NSFIE, the FIES is conducted over the whole calendar year. While these surveys have different sample coverage of households, and other conceptual differences, they are broadly comparable in the coverage of workers' households. Using 10 major consumption categories in NSFIE and FIES for workers' households, I calculated seasonal adjustment coefficients as the ratio of reported values in FIES and NSFIE in the same calendar year. Then these coefficients were used to extrapolate major consumption categories in the NSFIE data to the whole calendar year.

Another adjustment was made to the age of household head in multi-generation households. Hayashi (1997, p. 425) noted that the design of NSFIE may create a sample selection bias when classifying household heads in such households. He also suggested a solution, by re-defining the head of multi-generation household as a member from younger generation, and I also used the Hayashi adjustment in this paper.

4.3 Missing data

The NSFIE data does not contain information for taxes and social security contributions for so-called 'other households', which in practice contain mostly individual proprietors. The data are missing for NSFIE waves in 1999 and 2004, while the earlier waves in 1989 and 1994 report taxes and social security contributions. Since these data are required to calculate disposable incomes, I imputed the missing observations in 1999 and 2004, using regression coefficients from 1989 and 1994 data.

Specifically, I predicted the rate of tax payments and social security contributions for 1999 and 2004, using parameter estimates from 'other households' in 1989 and 1994. The rate of tax payments and social security contributions was predicted by annual income, gender and age of household head, region of residence, and a year dummy for 1989. Predictions were calculated by a routine for multiple-imputations of missing observations in software STATA (version 12). To avoid predictions of unrealistic tax rates, I imposed restriction that predicted tax rates remain in the interval between 0 and 1.

4.4 Data cleaning

When cleaning the NSFIE data, I first omitted households that were flagged as unreliable. As shown in Table 1, this criterion reduced the sample size from 192,599 to 189,107 households.

I also omitted households with top-coded observations in the following three categories: (a) high annual income[3], (b) households with many members (namely, 8 and more household members), and (c) households with advanced age of household head (*i.e.*, 85 year and more). In addition, I omitted households that had negative estimates of disposable income or nondurable consumption. These criteria reduced the sample size to 186,732 households.

Finally, I omitted households that were likely to be outliers, using both tails in the distribution of saving rates, with cut-offs at 5 and 95 percentiles. This resulted in the final sample of 168,058 households.

4.5 Alternative data sources for family types

In this paper, households were classified into 5 family types, as discussed in subsection 2.2. Table 2 compares the household composition by family types, using published reports of the NSFIE, and the population census of Japan. Panel (a) reports family shares from published NSFIE reports, which are based on the complete sample of households. In contrast, family shares in Panel (b) are calculated from the 80 percent subset of the NSFIE data, while Panel (c) shows family shares in the final sample of 168,058 households that remained after data cleaning. Overall, differences between family shares in Panels (a), (b) and (c) are minor, always less than 1 percentage point, indicating that the sub-sample of NSFIE data in this paper was broadly comparable to the survey's full sample.

In addition, Panel (d) reports family shares from the most comprehensive data source, the population census of Japan. Similarly to the NSFIE, the census is conducted every five years. However, there is a one year shift between the NSFIE and the population census, so that the NSFIE for 1989 can be compared only to the Population Census for 1990.

As shown in Panels (a) and (d), there are minor differences in the coverage of family types by the NSFIE and population census. For single households, population shares converged over time, but other family types had differences in the range of 2-4 percentage points. In particular, the NSFIE evidently over-samples couples (both with children and without children), while single parents with children and non-nuclear households are under-sampled. Due to these differences in the household structure, I calculated the

[3] The upper limit for single households was 10 million yen, while for households with two or more members, it was 25 million yen.

impact of demographic structure with both NSFIE and population census. In practice, these alternative household weights produced very similar results.

5 Results

5.1 Estimates of age-cohort-period effects on household savings

Estimation results for Models 1 and 2 are reported in Table 3. The nonparametric part of these models was the same, with only a nonparametric term $f(a)$ for age effect, while the parametric part of Model 2 differed by several demographic variables. The overall goodness-of-fit is measured by the ratio of explained deviance. It is similar to the R^2 statistic in linear regression models[4], with higher values indicating a better fit. As shown in the bottom of Table 3, Model 2 had a higher goodness of fit compared with Model 1, 6.94 and 3.97 percent, respectively.

Estimates of cohort effect in both models showed increasing saving rates for more recently born cohorts, with almost all effects having statistically significant estimates. For example, compared with the control category, the birth cohort 1905 - 1909, the saving rate of birth cohort 1975-1979 was 9.33 percentage points higher in Model 1. In contrast, estimates of period effects were relatively modest, always less than 2 percentage points in both models.

Estimates for demographic effects in Model 2 indicated a relatively large impact on the saving rate, especially for different numbers of adults. The control category was households with no adult members (defined by the age between 18 and 65 years old). The addition of one adult increased saving rate by 8.58 percentage points, and by as much as 16.5 percentage points for 4 and more adults. Conversely, children reduced household saving rates, by around 5 percentage points. Finally, the estimated effect of aged and retired household members was statistically significant and positive, which does not support the LCH. For example, with only one aged and retired household member, the saving rate increased by almost 2 percentage points. The positive effect was even larger for two and more such members, by 5.57 percentage points.

Nonparametric estimate of age effect for Models 1 and 2 is shown in Panels (a) and (b) of Figure 2. As reported at the bottom part of Table 3, the number of estimated degrees of freedom was 7.10 and 7.08, respectively, indicating a complicated structure of age effects in both models. The nonparametric estimate of age effect shows that the saving rate was increasing up to the middle age, but then declined during the late 40s and 50s. When demographic effects were added to Model 2, this greatly decreased the

[4] Estimated semiparametric models belong to the normal family of generalized linear models with identical link function, and their deviance is made up of the sum of squared residuals. The ratio of explained deviance compares deviances of two models: the null model with just the intercept term, and the alternative model with all explanatory variables. Let these deviances by D_0 and D_1, respectively. Then the deviance explained is $(D_0 - D_1)/D_0$.

amplitude of variation in the age effect on saving, and produced an unexpected jump in the saving rate for oldest households.

Table 4 reports estimates for Models 3 and 4. The the goodness of fit was the highest for Model 4, with the ratio of explained deviance increased from 11.2 in Model 3 to 12.0 in Model 4.

When the full set of parametric controls was added to Models 3 and 4, some cohort effects were no longer statistically significant (especially this applies to recently-born cohorts). In contrast, all estimates of period effects became significant, with a general increase in the saving rate by 2-3 percentage points compared with the control year 1989. The positive effect from adult members became much smaller compared with Models 1 and 2. On the other hand, little change occurred for the effect of children, who reduced household saving rate in the range of 2-6 percentage points. Finally, the effect from aged and retired household members was negative, but was statistically significant only in households that had only one such a member.

Estimates for new parametric effects in Models 3 and 4 produced a few relatively large effects. Compared with the control category of single households, all other family types had higher saving rates, with a particularly large difference for extended households, which increased the saving rate by almost 6 percentage points. A similarly large effect was from differences in employment status, with difference of 7.8 percentage points between full-time workers (the control category) and part-time workers.

Nonparametric estimates of age effects on saving for Model 3 are plotted in Panel (c) of Figure 2. With the full set of parametric controls, the variation in age-saving profile was greatly reduced, to only 6 percentage points over the whole life cycle. Moreover, the saving rate of aged households declined much less, indicating that a substantial part of reduced saving rate in Models 1 and 2 was explained away by extra control variables of Model 3.

Figure 3 reports estimates of differentiated age profiles for different family types in Model 4. Panel (a) shows that the saving rate of single households rose up to the early 40s, but then was declining until early 60s, and then stayed mostly flat. The estimated profile does not fit well with the conventional life-cycle theory of savings. In particular, single households started to reduce their saving rate much too early, and did not show a clear reduction in saving rate in old age. For couples without children, estimated saving profile turned out similar to single households, with the only difference that peak saving rate was reached about ten years later.

Households with children, including couples and single parents, provided the closest match with the humped-shaped profile of savings; it is ironic that the life-cycle theory largely ignores these family types. In particular, couples with children and single parents greatly reduced their saving rate in the old age (Panels (c) and (d) of Figure 3). As for the the saving profile for multi-generation households in Panel (e), its interpretation is difficult because these households combine members at different stages of their life cycle.

Out of four considered models, which one can be considered as the best one? The ratio of explained deviance selects Model 4. The same conclusion is reached by the Akaike Information Criterion (AIC), as reported at the bottom of Tables 3 and 4. Though Model 4 used a large number of parameters to approximate nonparametric effects age effects in different family types, this complexity was more than counter-balanced by greatly improved fit, which led to the superior AIC score for Model 4, with Model 3 showing a slightly worse performance. In consequence, I used Model 4 to derive the aggregate contribution of age, cohort and period effects on household saving rates.

5.2 Calculation of aggregate demographic effects

In this sub-section I calculate the aggregate effect on household saving rates that can be attributed to differences in age and cohort structure of the population, and other factors that were estimated in Model 4. Table 5 illustrates the calculation for the age effect, using the population structure of Japan from the population census in 2005.

The original nonparametric estimates of age effects in Figure 3 does not show point estimates for specific ages, but interval estimates in the age range from 20 to 84 years. These interval estimates of nonparametric effects were averaged by 5-year bands (namely, 20-24, 25-29, 30-34, . . . , 80-84), and the corresponding point estimates are reported in the left side in Table 5. For example, age effect among single households in the age range 20-24 was -3.28 percentage points, which corresponds to the original nonparametric estimate in Panel (a) of Table 4, with the only difference that average point estimates in Table 5 are multiplied by 100.

The second column of Table 5 shows average point estimates for couples, with the age group of 20-24 years having -6.34 percentage point reduction in the saving rate. The relatively large negative effect for the second family type for the youngest age group is evident by comparing Panels (a) and (b) of Figure 3.

The right side of Table 5 shows weights by different age groups across five family types in 2005. Using these weights and point estimates of age effects, I calculated the aggregate effects on household saving rate from the Japan's age structure in 2005 for five different household types. For example, the aggregate effect for single households was -1.52 percentage points, reflecting negative age effects for single households among the youngest and oldest age groups, and the relative concentration of single households among youngest and oldest age groups. Similarly, the aggregate effect for the second family type, couples without children, was -1.82 percentage points. This estimate reflects two distinctive feature of couples without children: first, the relative prevalence of aged households, and relatively large negative age effects for couples that are older than 60 years old.

The aggregate effect for the next two family groups (couples with children and single parents with children) were positive, at 0.11 and 1.09 percentage points, while the estimate for extended households for -1.14 percentage points. To calculate the total contribution of age structure on household saving rate, these separate contributions for five family types were multiplied by corresponding weights in populations structure (namely, 0.292 for single households, 0.196 for couples, etc.). The resulting estimate of the net change in household saving rate for 2005 was -0.82 percentage points (shown in the last row of Figure 5).

The contribution from changing structure of birth cohorts was calculated in a similar way. The left side of Table 6 shows two sets of parameter estimates for cohort effects. The first set includes all estimates of cohort effects from Model 4, which were already reported in Table 4. Around half of these estimates turned out statistically insignificant, as illustrated by Figure 4. The first birth cohort is used as a control category, with zero coefficient.

As shown in Figure 4, subsequent birth cohorts from 1920-1914 to 1930-1934 had statistically significant positive estimates, followed by a long sequence of insignificant cohort effects, with only a single significant (and negative) estimate for the youngest birth cohort of 1980-1984. Due to the large number of insignificant estimates, I also used a second set of cohort estimates, which were significant at 5 percent level, while insignificant ones were zero.

The right side of Table 6 contains weights for different birth cohorts, which were calculated from different rounds of NSFIE survey in 1989, 1994, 1999 and 2004. With each subsequent survey, the share of a given birth cohort declines. For example, household heads that were born in 1920-1924 accounted for 5.1 percent of households in 1989, but for only 2.4 percent of households in 2004. As shown in Figure 4, older birth cohorts tended to have relatively high saving rate, with increased saving rate by around 4 percentage points for those born between 1910 and 1929. As the older birth cohorts decreased their share in the household structure over time, the net effect of the cohort effects is expected to be negative.

The bottom part of Table 6 illustrates this trend in the historical contribution of cohort effect. For example, the aggregate contribution of cohort effect in 1989 was 1.81 percentage points with all estimates of cohort effects, and 1.25 percentage points with only significant estimates. But with declining share of birth cohorts with relatively high saving rates, the aggregate contribution from birth cohorts declined continuously, and dropped to 1.24 percentage points in 2004 with all estimates for cohort effects, while significant estimates also produced the estimate of 0.70 percentage points, which was lower compared with estimates for previous years.

Table 7 summarizes contributions to household saving rate from age, cohort and period effects. It contains two alternative estimates for different age structure among households. The first estimate uses household weights from different round of population census of Japan (namely, in 1990, 1995, 2000 and 2005)[5]. The second estimate uses household weights in NSFIE samples (namely the final sample of 168,058 households that I obtained after data cleaning, as shown in Table 1). Using this second set of weights, I got very similar estimates for the aggregate contribution of age structure. For example, the estimate with NSFIE weights in 1989 was -0.68 percentage points, which was not much different from the estimate of -0.82 percentage points, derived in Table 5 with weights from 1990 population census.

Table 7 also reports two estimates for the aggregate contribution of cohort effects (namely, with all and only significant estimates) that were calculated in Table 6. Finally, estimates for period effect are taken from parameter estimates for year dummies in Model 4 (reported in Table 4). The control category for period effects was the first survey year (1989), against which the household saving rate increased by 1.83 percentage points in 1994, by 2.67 percentage points in 1999 and by 1.75 percentage points in 2004.

Compared with these changes in period effect on saving rates, how large was variation in the contribution of age and cohort effects? Similarly to the contribution of period effect, I set the aggregate contribution of age and cohort effects in 1989 (or 1990 in the case of census weights) to zero, and calculated net change over time in these effects compared with the initial level. The bottom part of Table 7 reports these net changes in age and cohort effects over time. I begin with the net effect from changes in age structure of households. With census weights for household weights, these was almost no change in the aggregate age effect over time; in fact, the aggregate contribution in 2005 turned out exactly the same as it was in 1990. With NSFIE weights, changes in the age structure also had a minor negative effect on household saving rate, by -0.16 percentage points in 2004 compared with 1989.

Compared with surprising small effect from changes in age structure, the aggregate effect from the changing composition of birth cohorts was more pronounced. It reduced saving rate by 0.57 percentage points from 1989 to 2004 with all estimates of cohort effect, and by 0.55 percentage points with only significant estimates. But taking into account that the net aggregate effect was spread over 20 years, the impact from cohort effect on the saving rate is essentially nil.

Table 8 reports estimates of aggregate contribution of age and cohort effects, using mid-point projections of household structure by age by National Institute of Population and Social Security Research (2008). The projections are available in five-year intervals from 2010 to 2030.

The aggregate effect from the age structure of households is around 0.80 percentage point, and changes little over time. In fact, the estimate for 2030 is very close to its level in 2010, indicating that differences in the age structure of households may have negligible impact on the future household saving rate. The aggregate effect from different birth

[5] Table 5 have already illustrated the calculation with these weights for year 2005.

cohorts showed a more noticeable change. For example, with only significant estimates of cohort effects, the aggregate saving rate dropped from 0.33 percentage points to -0.35 percentage points in 2030, reflecting the reduced share of cohorts with relatively high saving rates. However, this change in 0.68 percentage points over the span of 20 years implies that at annual rate, the effect on saving rate is just -0.03 percentage points a year.

6 Conclusion.

Using micro data from the National Survey of Family Income and Expenditure, this paper estimated the effect of age, birth cohorts and other factors on changes in household saving rates in Japan. Four major findings stand out in estimates of these effects.

First, I found that different types of households had vastly different age-saving profiles, with little evidence of a common saving pattern among households. Consequently, studies that assume uniform age-saving profiles across different family types are likely to miss the substantial diversity in saving behavior. Second, the estimates produced little evidence to support a humped-shaped profile of savings, as predicted by the life-cycle hypothesis of savings. For example, households without children started to decrease their saving rate much earlier that postulated by the life-cycle theory, and this pattern was evident both for single households, and for couples. Moreover, I found even less evidence of humped-shaped savings in other family types, with a notable absence of reduced saving saving rate among aged households in most family types. Fourth, when households were differentiated by the number of aged and retired household members, the presence of such members did not significantly reduce the rate of household savings, indicating that dissaving in the old age may be largely absent in the Japanese household data.

Using the estimates of age effects, I calculated the aggregate effect from demographic structure on the household saving rate in Japan. At a given point of time, the aggregate effect from different age groups was negative, but very small in magnitude, always within one percentage point. Moreover, the variation in the aggregate age effect over time was even less evident, indicating a negligible impact on the household saving rate from changing age structure in Japan.

Why the age compositional effect of the life-cycle theory turned out of such a limited scale in Japan? One possible reason is that estimated age-saving profiles did not have large enough variation in humped-shaped savings, with a particular lack of sufficiently steep declines in the saving rate of aged households. In fact, for some family types, the saving rate did not decline in the old age, but either stayed flat, or even increased.

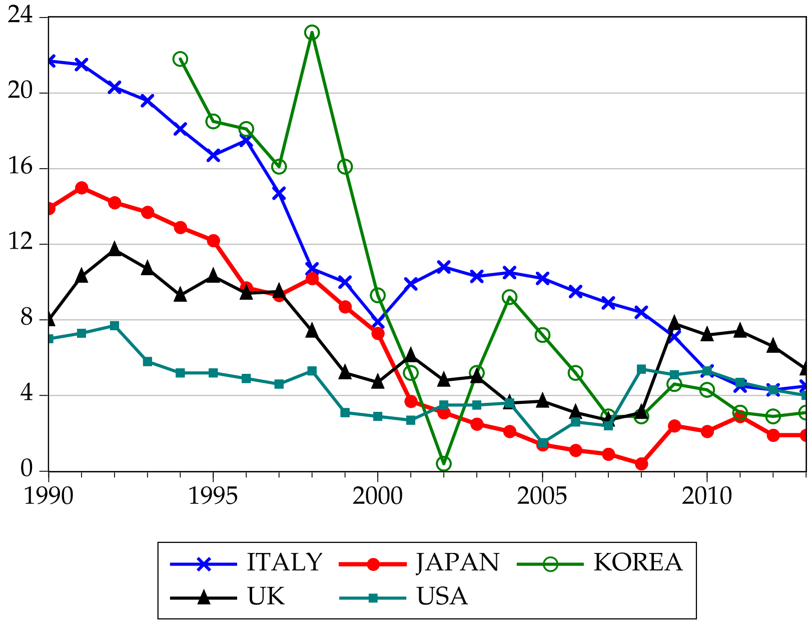
Compared with the small effect from differences in the age structure of Japanese households, changes in the composition of birth cohorts had a larger effect on the saving rate. In particular, I found that older birth cohorts of Japanese households were relatively higher saving rates, but the difference across cohorts mostly disappeared after the baby-boom generation. Since the population aging reduces the population share of older birth cohorts with relatively high saving rates, the aggregate cohort effect has been reducing the rate of household savings, by about -0.6 percentage points, with the effect spread over 1989–2004.

The paper also applied the estimates of age and cohort effects on savings to projections of the future structure of Japanese households by age and family types. Once again, the net change in the contribution of the age effect was only 0.01 percentage points over 2010–2030, while the corresponding estimate for the aggregate cohort effect was only -0.6 percentage points, with an average annual change by just -0.03 percentage points.

In general, the results in this paper agree with other micro-level evidence on the little importance of demographic factors for aggregate household savings. Rather than demographics, a more important factor seems to be uniform changes in saving behavior across different age and cohort groups, when for some unknown reason, people decide to save their saving behavior, and the new applies equally to all age and cohort groups. These changes *in parallel* across different demographic groups were pointed by Bosworth *et al.* (1991), and have been subsequently identified among households in other countries (Deaton and Paxson, 2000). In this paper, I also found that these common changes in saving behavior, expressed by large estimated period effects, were important among Japanese households too, especially in comparison with the small compositional effects from the demographic structure. But what drives these common changes in saving behavior remains a puzzle.

Figure 1. Household saving rates (%).

The figure plots household saving rates, calculated from national accounting system SNA93. Italy, Japan and Korea report household saving on a net basis (namely, excluding consumption of fixed capital by households and unincorporated businesses), while gross saving rates are reported by the United Kingdom and the United States. Household include the household sector and non-profit institutions that serve households.



Source: OECD (2012).

Table 1. Changes in the sample size at different stages of data cleaning

1. Original sample size	192,599
2. Less households, marked for unreliable data	189,107
3. Less households with top-coded income	187,786
4. Less households with negative disposable income or nondurable consumption	187,401
5. Less households with topped-up age (85 y.o.)	186,732
6. Less households in 5% tails of saving rate's distribution	168,058

Table 2. Comparison of different data sources for family type shares.

	Singles	Couples	Couples & child(ren)	Single parents & child(ren)	Non-nuclear households
(a) NSFIE (published report)					
1989	19.9	16.2	44.1	3.2	16.6
1994	21.1	19.2	42.2	3.2	14.2
1999	27.7	20.9	36.7	3.7	11.1
2004	29.1	22.8	34.1	4.2	9.9
(b) NSFIE (80% subset of micro data)					
1989	19.2	15.8	42.8	2.2	19.9
1994	20.5	18.7	40.6	3.0	17.3
1999	26.9	20.4	35.3	3.1	14.3
2004	28.2	22.0	32.8	3.6	13.3
(c) NSFIE (after cleaning)					
1989	17.7	15.8	44.6	2.0	19.9
1994	18.8	19.0	42.6	2.5	17.1
1999	24.6	21.0	37.5	2.6	14.3
2004	26.7	22.3	34.7	3.2	13.1
(d) Population census					
1990	23.0	15.4	37.5	6.7	17.3
1995	25.5	17.3	34.5	7.0	15.6
2000	27.4	18.8	32.3	7.6	13.9
2005	29.2	19.6	30.3	8.3	12.6
(e) Comprehensive Survey of People's Living Conditions					
1989	20.0	16.0	39.3	5.0	19.7
1995	22.6	18.4	35.3	5.2	18.5
1998	23.9	19.7	33.6	5.3	17.5
2004	23.4	21.9	32.7	6.0	16.1

Table 3. Regression estimates with a general age effect on household savings

The table reports estimates of regression models (8), (9), and (10), with a single non-parametric effect for general age effect $f(age)$. Dependent variable is the saving rate of households (in percent). Acronym 'edf' stands for the number of estimated degrees of freedom for nonparametric terms.

	Model 1		*Model 2*	
	Estimate	t-value	Estimate	t-value
Parametric effects				
Intercept	30.33	24.90	18.91	15.49
Cohort (1910-14)	2.90	2.18	3.50	2.68
Cohort (1915-19)	2.53	1.99	3.01	2.41
Cohort (1920-24)	4.36	3.51	4.86	3.98
Cohort (1925-29)	5.35	4.29	5.30	4.31
Cohort (1930-34)	4.77	3.82	4.15	3.38
Cohort (1935-39)	4.69	3.77	3.50	2.86
Cohort (1940-44)	5.04	4.07	3.36	2.75
Cohort (1945-49)	5.46	4.43	3.79	3.11
Cohort (1950-54)	6.14	5.00	4.14	3.41
Cohort (1955-59)	7.45	6.08	5.26	4.34
Cohort (1960-64)	8.18	6.70	5.59	4.62
Cohort (1965-69)	9.78	8.01	6.82	5.63
Cohort (1970-74)	9.14	7.44	6.01	4.91
Cohort (1975-79)	9.33	7.44	5.78	4.62
Cohort (1980-84)	5.21	3.75	1.15	0.83
Year = 1994	0.55	3.92	1.06	7.61
Year = 1999	0.31	2.10	1.40	9.31
Year = 2004	-1.74	-11.14	-0.16	-0.97
Adults = 1			8.58	33.65
Adults = 2			15.43	57.11
Adults = 3			17.66	61.40
Adults $\geq$ 4			16.45	55.31
Children = 1			-4.85	-27.78
Children = 2			-4.94	-26.83
Children $\geq$ 3			-5.77	-22.67
Age>65 & retired = 1			1.95	13.21
Age>65 & retired $\geq$ 2			5.57	24.23
Nonparametric effects				
	edf		*edf*	
$f(age)$	7.10***		7.08***	
Model-selection criteria				
Deviance explained (%)	3.97		6.94	
AIC score	1,519,359		1,514,101	
Number of households	168,058		168,058	

Figure 2. Nonparametric estimates of general age-saving profiles.

The figure reports estimated age-saving profiles in Models 1, 2 and 3 that use a common nonparametric term for the age effect on savings, and differ only in the composition of parametric effects. Model 1 contains only cohort and period effects, Model 2 adds two demographic variables (the number of adults and children), while Model 3 has the most extensive list of control variables. Detailed parameter estimates for Models 1, 2, and 3 are given in Table 1. The y-axes reports the estimated number of degrees of freedom to approximate nonparametric age effects.

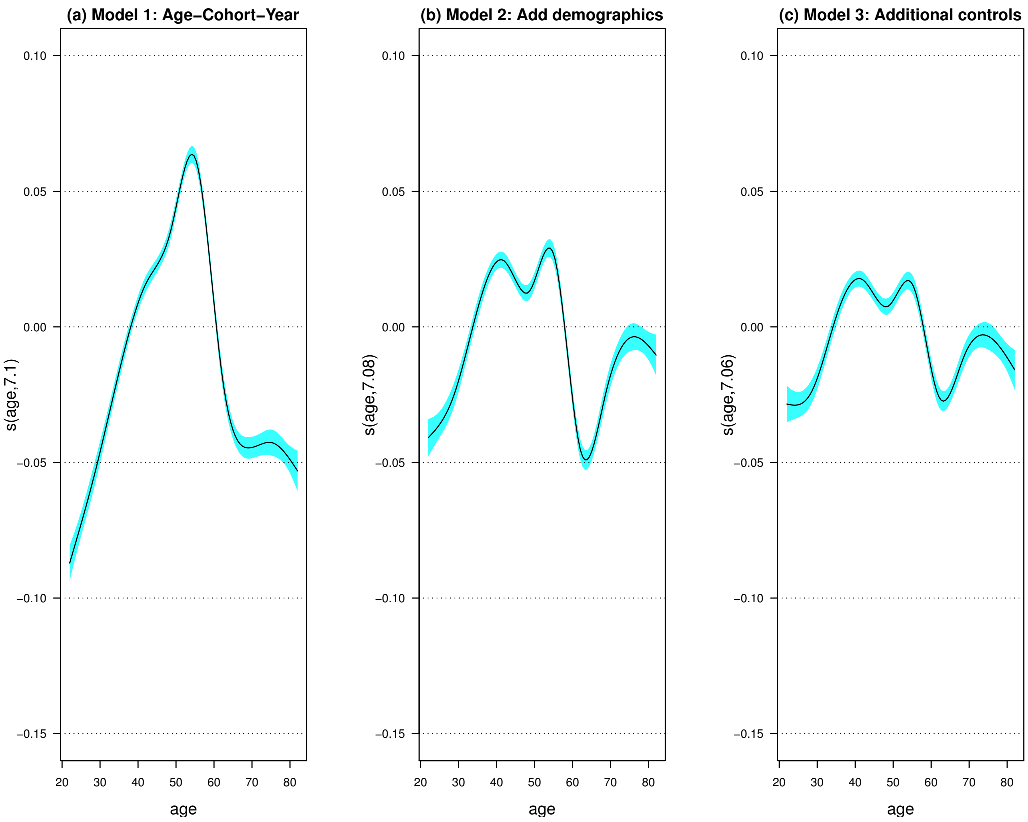


Table 4. Regression estimates with differentiated age effects on household saving

The table reports estimates of semiparametric models (10) and (12). The dependent variable is the saving rate of households (in percent).

	Model 3		Model 4	
	Estimate	t-value	Estimate	t-value
Parametric effects				
Intercept	34.36	27.47	35.88	27.37
Cohort (1910-14)	4.80	3.76	4.34	3.40
Cohort (1915-19)	3.80	3.11	3.32	2.71
Cohort (1920-24)	4.97	4.16	4.66	3.86
Cohort (1925-29)	4.87	4.05	4.62	3.78
Cohort (1930-34)	3.24	2.70	2.90	2.35
Cohort (1935-39)	2.43	2.03	2.11	1.70
Cohort (1940-44)	1.53	1.28	1.40	1.12
Cohort (1945-49)	0.94	0.79	0.83	0.66
Cohort (1950-54)	0.61	0.52	0.48	0.38
Cohort (1955-59)	0.96	0.81	0.76	0.58
Cohort (1960-64)	0.76	0.64	0.70	0.53
Cohort (1965-69)	1.45	1.21	1.64	1.22
Cohort (1970-74)	-0.26	-0.22	0.26	0.19
Cohort (1975-79)	-1.60	-1.30	-0.87	-0.60
Cohort (1980-84)	-5.76	-4.21	-5.25	-3.31
Year = 1994	1.89	13.77	1.83	12.55
Year = 1999	2.84	18.87	2.67	14.70
Year = 2004	2.08	12.37	1.75	7.68
Adults = 1	-0.38	-1.25	-1.49	-4.10
Adults = 2	1.20	2.65	-0.64	-1.26
Adults = 3	1.89	3.76	-1.29	-2.34
Adults $\geq$ 4	0.04	0.08	-2.93	-5.12
Children = 1	-4.35	-22.99	-2.38	-11.30
Children = 2	-4.82	-23.11	-3.14	-13.46
Children $\geq$ 3	-5.95	-21.87	-4.43	-15.17
Age>65 & retired = 1	-1.12	-4.89	-0.60	-2.39
Age>65 & retired $\geq$ 2	-0.42	-1.17	-0.50	-1.29
Different family types:				
Family type 2: Couple only	0.29	1.07	1.72	4.88
Family type 3: Couple & child(ren)	0.56	1.70	1.44	3.83
Family type 4: Parent & child(ren)	2.69	7.01	1.80	4.20
Family type 5: Multi-generation	5.88	13.86	5.85	12.71
3 major metropolitan districts	-1.69	-17.57	-1.73	-18.07
Job contract: part-time	-8.15	-26.93	-7.79	-25.67
Job contract: none	1.55	9.51	1.51	9.29
Head of household: female	-7.03	-38.48	-6.72	-35.84
Nonparametric effects				
	edf		*edf*	
f(age)	7.06			
f(age):family type 1 (Single)			8.20	
f(age):family type 2 (Couple only)			7.31	
f(age):family type 3 (Couple & child(ren))			7.90	
f(age):family type 4 (parent & child(ren))			7.39	
f(age):family type 5 (Multi-generation)			7.59	
Model-selection criteria				
Deviance explained (%)	11.2		12.0	
AIC score	1,506,136		1,504,714	
Number of households	168,058		168,058	

Figure 3. Age-saving profiles across different household types in Model 4.

The figure reports estimated age-saving profiles in Model 4, specified by equation (12). Detailed parameter estimates are given in Table 2. The y-axes reports the estimated number of degrees of freedom to approximate the shape of age effect.

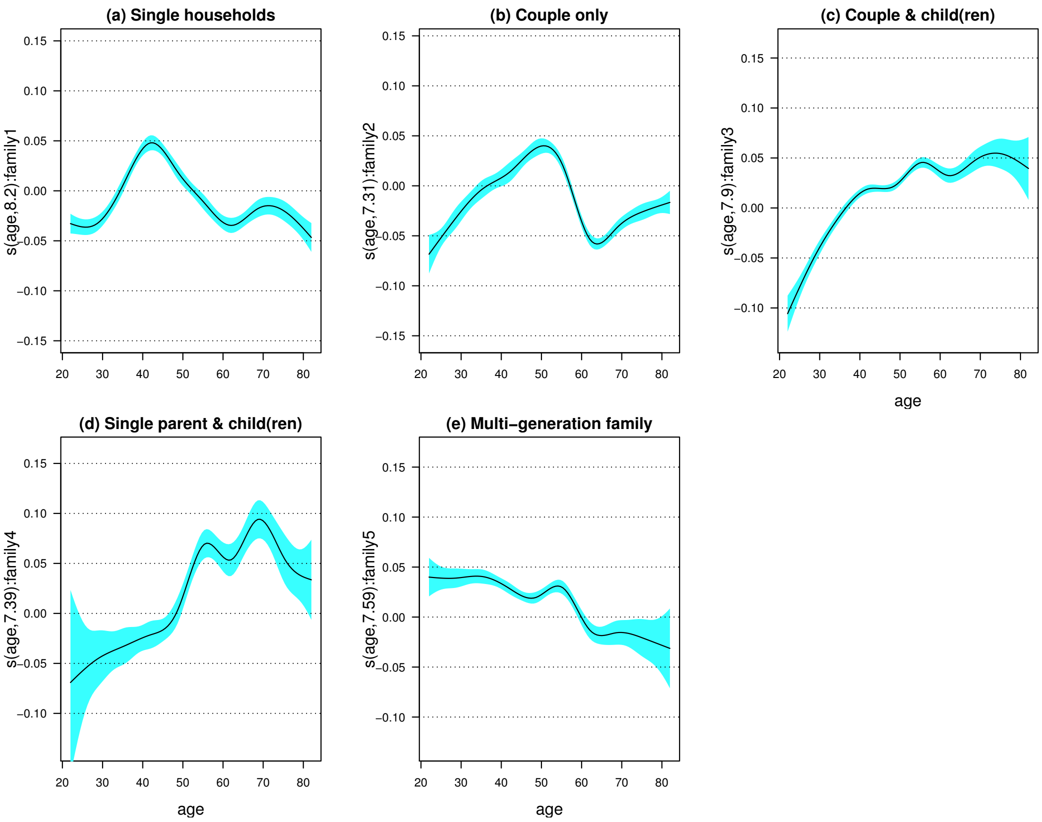


Figure 4. Age-saving profiles across different household types in Model 4.

The figure reports 95% confidence intervals for cohort effects on savings, estimated by Model 4. Birth cohorts are denoted by the mid-point of corresponding 5-year interval (for example, 1907 on the x-axis denotes the birth cohort of 1905-1909).

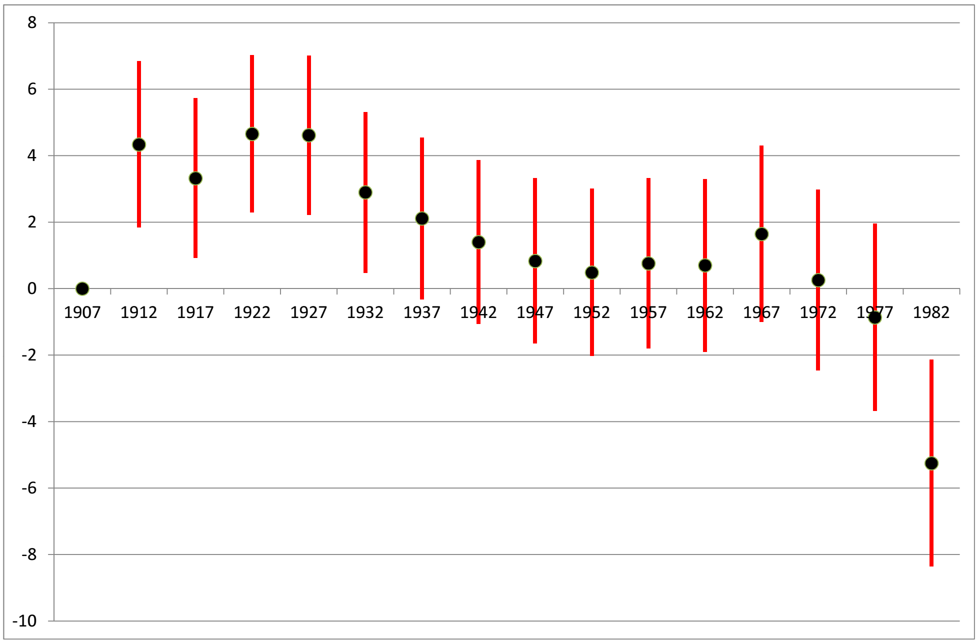


Table 5. Calculation of the aggregate age effect in 2005.

The table reports point estimates of age effects on the saving rate for different family types, and the age structure for these family types in 2005. Age structure is based on weights from the population census. The following abbreviations for family types are used: S = single households, C = couples, C & Ch = couples with children, S & Ch = single parents with children, Ex = extended (non-nuclear) households.

	Point estimates of the age effects					Weight by age group in 2005				
	S	C	C & Ch	S & C	Ext	S	C	C & Ch	S & C	Ext
Age group:										
20-24	-3.28	-6.34	-12.29	-8.35	2.19	0.155	0.006	0.007	0.007	0.016
25-29	-3.58	-3.61	-7.94	-6.50	2.07	0.115	0.040	0.039	0.025	0.023
30-34	-1.70	-1.09	-4.30	-5.28	2.25	0.096	0.063	0.104	0.059	0.029
35-39	2.14	0.63	-1.47	-4.41	2.09	0.071	0.045	0.127	0.085	0.038
40-44	4.80	1.85	0.18	-3.57	1.06	0.057	0.033	0.129	0.110	0.060
45-49	2.93	3.78	0.25	-2.34	0.09	0.051	0.030	0.120	0.121	0.090
50-54	0.26	4.36	1.82	2.67	1.01	0.063	0.055	0.124	0.135	0.132
55-59	-1.98	0.67	2.71	5.46	0.34	0.079	0.110	0.130	0.139	0.167
60-64	-3.46	-4.81	1.53	3.92	-3.09	0.067	0.147	0.091	0.095	0.127
65-69	-2.26	-4.48	2.52	7.26	-3.52	0.066	0.161	0.060	0.074	0.104
70-74	-1.50	-2.69	3.68	6.67	-3.47	0.070	0.151	0.038	0.062	0.093
75-79	-2.57	-1.82	3.47	3.08	-4.17	0.064	0.108	0.021	0.050	0.077
80-84	-4.67	-1.16	2.23	1.93	-4.94	0.046	0.050	0.009	0.037	0.045
Change in the saving rate for the family type:										
	-1.52	-1.82	0.11	1.09	-1.14	0.292	0.196	0.303	0.083	0.126
Aggregate change in the saving rate:					-0.82					

Table 6. Calculation of the aggregate cohort effect

The table reports point estimates of cohort effects on the saving rate for different family types, and the cohort structure for these family types. Cohort weights are calculated from the NSFIE data of 168,058 households. The following abbreviations for family types are used: S = single households, C = couples, C & Ch = couples with children, S & Ch = single parents with children, Ex = extended (non-nuclear) households.

	Estimates		Weights by cohorts			
	All	Only significant	1989	1994	1999	2004
Birth cohorts:						
1905-09	0.00	0.00	0.007			
1910-14	4.34	4.34	0.017	0.010		
1915-19	3.32	3.32	0.036	0.023	0.013	
1920-24	4.66	4.66	0.051	0.048	0.036	0.024
1925-29	4.62	4.62	0.076	0.081	0.068	0.058
1930-34	2.90	2.90	0.090	0.084	0.086	0.083
1935-39	2.11	2.11	0.101	0.089	0.090	0.095
1940-44	1.40		0.124	0.113	0.099	0.100
1945-49	0.83		0.144	0.128	0.112	0.103
1950-54	0.48		0.138	0.130	0.111	0.101
1955-59	0.76		0.104	0.109	0.100	0.096
1960-64	0.70		0.074	0.092	0.097	0.092
1965-69	1.64		0.039	0.062	0.083	0.091
1970-74	0.26			0.031	0.077	0.080
1975-79	-0.87				0.028	0.056
1980-84	-5.25	-5.25				0.022
Change in the saving rate due to cohort effect:						
With all estimates			1.81	1.74	1.52	1.24
With only significant estimates			1.25	1.15	0.96	0.70

Table 7. Summary of aggregate age, cohort and period effects in historical changes of household saving rate in Japan.

The table summarizes the aggregate contribution of age, cohort and period effects on household saving rate from 1989/1990 to 2004/2005. The contribution of age effect in 2005 (with census weights) is taken from Table 5. Two alternative contributions from cohort effects is taken from Table 6. The contribution of period effects is taken from parameter estimates for Model 4 in Table 4.

	1989/1990	1994/1995	1999/2000	2004/2005
(a) Annual point estimates:				
Age effect				
a. Census weights	-0.82	-0.86	-0.85	-0.82
b. NSFIE weights	-0.68	-0.75	-0.86	-0.84
Cohort effect				
a. All coefficients	1.81	1.74	1.52	1.24
b. Significant coefficients	1.25	1.15	0.96	0.70
(b) Change in effect compared with 1989/1990:				
Period effect	0.00	1.83	2.67	1.75
Age effect				
a. Census weights	0.00	-0.04	-0.04	0.00
b. NSFIE weights	0.00	-0.08	-0.19	-0.16
Cohort effect				
a. All coefficients	0.00	-0.07	-0.28	-0.57
b. Significant coefficients	0.00	-0.10	-0.29	-0.55

Table 8. Projected effect of the demographic structure on household saving rate in Japan

The table summarizes the aggregate contribution of age and cohort effects on future household saving rates. Household weight are taken from mid-point projections by National Institute of Population and Social Security Research (2008). Calculations in Panels (a) and (b) may not agree due to rounding errors.

	2010	2015	2020	2025	2030
(a) Annual point estimates:					
Age effect	-0.80	-0.72	-0.68	-0.71	-0.80
Cohort effect					
a. All coefficients	0.85	0.76	0.60	0.36	0.22
b. Significant coefficients	0.33	0.18	0.00	-0.32	-0.35
(b) Change in effect compared with 2010:					
Age effect		0.09	0.13	0.09	0.01
Cohort effect					
a. All coefficients		-0.09	-0.24	-0.49	-0.63
b. Significant coefficients		-0.15	-0.33	-0.65	-0.68

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