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LIFE-CYCLE SAVING IN THE UNITED STATES, 1900–90

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This paper examines how the proportion of US saving that represents life-cycle accumulation changed over the last century. As individuals retire earlier and live longer than before, the expected length of male retirement has increased by more than six-fold since 1850. According to life-cycle models of saving, this means that the proportion of lifetime income saved for retirement should rise over time. I estimate that the fraction of lifetime income saved for retirement tripled between 1900 and 1990. In contrast to such an increase in the estimated retirement saving, the actual aggregate household saving rates exhibit a relatively stable long-term tendency during the 20th century. Based on this result, I argue that the relative contribution of the life-cycle saving to US wealth accumulation increased substantially, perhaps two to three times, over the last hundred years.

1. INTRODUCTION

The relative importance of the various motives for wealth accumulation has been a major issue among economists. Distinguishing the role of each motive for saving in the capital accumulation process is crucial to a number of economic issues, such as the source of capital formation in the course of industrialization (Ransom and Sutch, 1986; Carter and Sutch, 1996), the impact on savings of intergenerational reallocations of resources generated by social security (Feldstein, 1974a; Barro, 1974, 1978), the nature of wealth inequality (Atkinson, 1971; Oulton, 1976), and the structuring of fiscal policies (Diamond, 1970).

The more traditional belief is that life-cycle saving is the main source of wealth accumulation (Modigliani and Brumberg, 1954; Ando and Modigliani, 1963; Modigliani, 1986). This view was challenged by the work of Kotlikoff and Summers (1981), in which they report that the bulk of wealth accumulation is due to intergenerational transfers. Empirical work to test the life-cycle hypothesis has been carried out on various grounds. A number of studies directly estimate the stock of wealth resulting from transfers and from life-cycle savings (Projector, 1968; Kotlikoff and Summers, 1981; David and Menchik, 1983; Ando and Kennickell, 1987). Economists have also investigated whether the age profile of wealth stock is hump-shaped as predicted by the life-cycle hypothesis (Shorrocks, 1975; Mirer, 1979; Ando, 1985; Bernheim, 1986; Hurd, 1987).

In spite of all the various work on this issue, the gap between the two views is still strikingly wide. It is suggested, on one hand, that about four-fifths of

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wealth accumulation result from retirement savings (Modigliani, 1988), while on the other hand only a fifth of current wealth stock is said to be accounted for by life-cycle accumulations (Kotlikoff and Summers, 1988). This wide difference results in part from a sharp disagreement on some conceptual and empirical issues which are critical for estimating the life-cycle wealth stock, such as how to treat property income, expenditure on durable goods, and consumption expenditures of adult children in measuring life-cycle wealth (Kotlikoff and Summers, 1988; Modigliani, 1988).

The purpose of this paper is to examine how the relative importance of life-cycle motives for saving has changed over time. This issue has been largely ignored by previous studies that focused on the absolute size of life-cycle wealth accumulation. In those studies, it is implicitly assumed that the relative magnitude of a particular motive for saving is stable over time. A widely used method in the literature is to estimate the proportion of the total wealth stock at a point of time that is accounted for by the cumulative amount of savings for a particular motive. Kotlikoff and Summers (1981), for example, infer the relative contribution of life-cycle savings from a comparison between their estimate of the life-cycle wealth accumulated between 1900 and 1974 and the net worth figure for the noninstitutional household sector in 1974. It is highly unlikely, however, that the relative size of saving from a particular motive remained unchanged. Therefore, the results of previous studies on the overall magnitude of life-cycle wealth accumulation, if correct, do not tell what percentage of the flow of saving in a particular year results from life-cycle motives.

Various features of human lives have been greatly transformed over the last century. These transformations should have influenced household saving behavior. A rapid rise in life expectancy and a sharp fall in the labor force participation rate (LFPR) of older males should have increased the average duration of retirement. A longer expected duration of retirement, according to the life-cycle hypothesis, means larger savings for retirement. The implementation of a wide range of social insurance programs, including social security, unemployment insurance, workers' compensation, and government-subsidized health care, may have diminished the demand for private insurance, which decreases the need for savings. In spite of the growing interest in the savings effect of such long-term demographic and institutional changes, there is still little empirical evidence about their magnitudes.

As a first step to filling this gap in the literature, this paper investigates the long-term time trend of the proportion of saving that represents accumulation for retirement. In particular, I focus on how long-term changes in mortality and labor force participation affect savings. The paper is organized as follows: in the next section, I begin the analysis by estimating how the expected length of retirement for each labor market cohort changed from 1850 to 1990. According to a simple life-cycle model of saving, a longer duration of retirement of a cohort indicates greater retirement consumption, and thus larger life-cycle saving needs. Based on an estimate of the duration of retirement, in section 3, I infer how the fraction of lifetime income saved for retirement (life-cycle saving rate) increased over the last century. In section 4, I determine the trend of the relative importance of life-cycle saving by comparing the estimated life-cycle saving rate to the actual household saving rate. The final section summarizes the results.

2. Expected Length of Male Retirement, 1850–1900

The past century has witnessed a rapid rise in life expectancy and a drastic fall in the LFPR of older males. At the beginning of the 20th century, males at age 20 would expect to live 42 additional years (Preston, Keyfitz, and Schoen, 1972, p. 724), compared to over 53 more years in 1990 (US Department of Health and Human Services, 1992a, p. 34). A century ago, 65 percent of males aged 65 or older were in the labor force (Moen, 1987a), compared to only 15 percent today. In analyzing how these changes in mortality and retirement rates affected life-cycle saving, the expected length of retirement at the age of entry into the labor force (ELR, hereafter) is a very useful variable. The ELR shows the combined outcome of changes in mortality and labor force participation. It is a key parameter associated with individual decisions of consumption and labor supply over the life cycle, as will be discussed in section 3. The following section explains the method and result of estimation of the ELR. More details on the method and some theoretical and empirical issues related with the estimation are found in Lee (1996).

For persons who retire at age x, the expected length of retirement is equal to their life expectancy at age x, denoted e_x. Among males in a cohort, the proportion of persons who would have an unconditional retirement period of e_x is equal to the probability of retiring at age x. Therefore, the expected retirement duration of a cohort is estimated by calculating a weighted average of life expectancy at each age of retirement. The relative size of a cohort who would have a retirement period of e_x (which is equivalent to the weight assigned to e_x) is determined by the probability of retiring at age x, which is the product of the following probabilities: the probability of remaining alive to age x (S_x), the probability of remaining in the labor force until age x conditional on surviving until age x (T_x), and the probability of retiring at age x conditional on remaining in the labor force at age $x(\gamma_x)$. Among the men who would retire between ages x and $x+1(S_x T_x \gamma_x)$, the proportion of those who die is given by the mortality rate within the age interval $({}_1q_x)$. If the likelihood of retirement does not vary within the age interval, half of these men would die before they leave the labor force. Therefore, the probability of retirement between ages x and $x+1$ is $S_x T_x \gamma_x[1-(0.5\times {}_1q_x)]$. For men who retire between ages x and $x+1$, the expected length of retirement is $(e_x + e_{x+1})/2$. Therefore, the expected length of retirement at age 20, chosen as the age of entry into the labor market, is as follows:

$$\text{(1)} \qquad \text{ELR} = \sum_{x=20}^{89} S_x T_x \gamma_x [1-(0.5\times {}_1q_x)][(e_x + e_{x+1})/2].$$

It is crucial in estimating the ELR to determine correctly how individuals form expectations about their future health and life expectancy. In this paper, two extreme assumptions are employed to establish the upper and lower bound estimates. One assumption is that a 20-year-old man assesses his retirement duration based on the expectation that current patterns of mortality and retirement remain unchanged in the future. Since individuals may anticipate a decline in mortality and the LFPR at older ages based on past trend, this assumption would lead to a lower bound estimate of the ELR. Period life tables and cross-sectional age profiles of the LFPR are used for applying this assumption to the calculation.[1] The resulting estimate is referred to as the *period estimate* throughout this paper.

The other assumption is that the timing of retirement and death is perfectly foreseen by each cohort. In reality, even if people adjust their expectations taking into account past experiences, they would likely fall short of the actual changes.[2] Therefore, the estimate derived from the second assumption is an upper bound. Cohort life tables and LFPR profile by age for each cohort are needed to apply this assumption. This estimate will be referred to as the *cohort estimate* hereafter.

The hazard of retirement at each age is estimated from Integrated Public Use Microdata Samples (IPUMS) of the censuses of 1850 through 1990 (Ruggles and Sobek, 1997). I use a five-year age interval in the actual estimation because it is difficult to estimate accurately the LFPR of older males for each single age due to the small sample size of men aged over 70 in the IPUMS. For the cohort estimate we need the retirement rates as of 1995 to 2055 because more recent cohorts will leave the labor force in the future. For instance, the majority of the cohort who entered the labor market in 1990 will retire between 2030 and 2055. The projections of the Social Security Administration (US Department of Health and Human Services, 1992b) are used for these years.[3] Interpolations are used for estimating the figures for 1890 and 1930 for which micro samples of the census are not available.[4] The mortality rate within each age range (${}_5d_x$) and life expectancy at each age (e_x) were collected from the period life tables reported in Haines (1994) and Preston *et al.* (1972), and the period and the cohort life tables in the US Department of Health and Human Services (1992a).

[1]I do not consider in constructing cohort-specific variables the possible effect of immigration. In reality, the composition of a cohort changed over time because of the continuous entry of immigrants to the US. In the present analysis, it is implicitly assumed that immigrants and natives are not different from each other in terms of the patterns of mortality and labor force participation. It appears that immigrants and natives were similar in the probability of retirement in the early 20th century (Lee, 1998). For those who survived until age 20, mortality differentials were relatively small. Although life expectancy of immigrants was shorter than that of the native born until the early 20th century, most of the difference was mainly due to the mortality differentials in childhood (Haines, 1977). Therefore, the potential bias due to the effect of immigration does not seem to be serious.

[2]Past changes in mortality have never been well predicted even by population experts. In the early 1970s, for example, the US Bureau of the Census claimed that no further major gains in life-expectancy would be achieved based on the mortality trend of the preceding decade. Also, today, scholars in a variety of fields are at odds over the future trend in adult mortality. There seems to be no consensus on the biological limits of the human lifespan (Ahlburg and Vaupel, 1990; Fogel, 1994).

[3]There are three alternative projections according to different assumptions. I use the upper projections of retirement rates because the purpose of the cohort estimate is to get an upper bound estimate of ELR.

[4]The current concept of the labor force has been in use since the 1940 census; the concept of gainful employment was used by the US census until 1930. Therefore, the data on the labor force before and after 1940 are not directly comparable. Following the conventional definition of the labor force employed for the censuses through 1930, I excluded from the counting of the labor force the following males aged 50 and over: inmates of institutions, individuals with no occupation, and those whose occupation was reported as "capitalist," "landlord" or "retired." For the definition of the labor force for the censuses through 1930 see Ransom and Sutch (1986), Moen (1987b), Margo (1993), and Lee (1998).

TABLE 1

THE EXPECTED LENGTH OF MALE RETIREMENT (ELR) IN COMPARISON WITH ADDITIONAL LIFE-EXPECTANCY (e_{20}) AT AGE 20

	(1) Period Estimate				(2) Cohort Estimate			
Year	(A) ELR (years)	(B) e_{20} (years)	(C) Number of Working Years	(D) Percent of Life Retired	(E) ELR (years)	(F) e_{20} (years)	(G) Number of Working Years	(H) Percent of Life Retired
1850	1.68	38.41	36.73	4.4	2.65	43.70	41.05	6.1
1860	1.77	40.32	38.55	4.4	3.18	43.95	40.77	7.2
1870	1.83	41.14	39.31	4.5	3.66	44.05	40.39	8.3
1880	1.62	39.65	38.03	4.1	4.27	45.65	41.38	9.4
1890	2.26	40.96	38.70	5.5	4.80	46.50	41.70	10.3
1900	2.93	41.73	38.80	7.0	5.50	47.29	41.79	11.6
1910	3.38	42.63	39.25	7.9	6.55	49.26	42.71	13.3
1920	4.38	44.45	40.07	9.9	8.24	51.36	43.12	16.0
1930	4.95	45.14	40.19	10.9	9.56	53.01	43.49	18.1
1940	5.76	46.77	41.01	12.3	11.59	54.32	42.73	21.3
1950	6.68	49.01	42.33	13.6	13.13	55.02	41.89	23.9
1960	7.88	49.65	41.77	15.8	14.26	55.54	41.28	25.7
1970	8.59	49.63	41.04	17.2	14.98	56.33	41.35	26.6
1980	11.27	51.73	40.46	21.7	15.65	57.17	41.52	27.4
1990	12.66	52.95	40.29	23.8	16.29	57.76	41.47	28.2

Source: Public-Use Micro Samples of censuses of 1850–80, 1900–20, and 1940–90 were used to estimate the age-specific retirement rates for these years. The retirement rates as of 1890 and 1930 were calculated by interpolations. Period life-tables are from Haines (1998) for 1850–90, from Preston, Keyfitz, and Schoen (1972) for 1900–60, and from the US Department of Health and Human Services (1992a) for 1970–90. Cohort life tables for 1900–90 come from the US Department of Health and Human Services (1992a). The cohort death rates in each age range for 1850 to 1890 were calculated from period life tables reported in Haines (1998). The cohort life expectancy at 20 was calculated based on the 10-year cohort life expectancy estimated by Pope (1992, table 9.2). See text for details on the calculation method.

Table 1 presents the period and cohort estimates of the ELR (columns A and E), period and cohort life expectancy (columns B and F), the expected age at retirement (columns C and G), and the ELR as a percentage of life expectancy at age 20 (columns D and H). The result suggests that the ELR has increased from 3–5 years in 1900 to 13–16 years in 1990. In 1900, a 20-year-old man would expect to spend 7–12 percent of his remaining lifetime in retirement. For the 1990 labor market cohort, the expected length of retirement represents nearly 30 percent of the length of their remaining lifetime.

3. TREND OF THE LIFE-CYCLE SAVING, 1900–90

The dramatic increase in the ELR measured as a percentage of the life expectancy at age 20 indicates that, all other things being equal, individuals should save an increasing portion of their incomes for retirement. Suppose, for simplicity, individuals perfectly smooth consumption over their life cycle and the rate of return to their savings is zero. In this case, the ratio of the expected duration of retirement to the length of working years, estimated in the preceding section (columns D and H in Table 1), suggests that the fraction of lifetime income saved for retirement increased from 7–12 percent in 1900 to 24–28 percent in 1990. In order to quantify such a potential growth of life-cycle saving, I consider below a simple life-cycle model of saving, in which life-cycle changes in consumption, non-zero rate of return to savings, and the effect of changing age composition on aggregate saving are, at least partially, taken into account.

As in a typical life-cycle model, we consider individuals who determine their lifetime paths of labor supply (including the timing of retirement) and consumption based on their expected age of death.[5] That is, they choose the expected length of retirement and size of savings which they expect will maximize their lifetime utilities. I assume that (1) there is no uncertainty about the age of death, and (2) there are no bequests. In other words, narrowly defined life-cycle saving (which excludes precautionary saving resulting from the uncertainty about the age of death) is the only source of wealth accumulation. We further assume that individuals make these life-cycle decisions when they enter the labor market, which in this model is set at age 0. The age of death is exogenously determined at age L. The age of retirement (N), and the amounts of consumption and income at a particular age j (C_j and Y_j) are determined by solving this life-cycle utility maximization problem. The interest rate is denoted r_j. In equilibrium, the present values of savings and retirement consumption are equal and satisfy the intertemporal budget constraint illustrated below, where S_j denotes the amount of saving at age j.

(2)
$$\sum_{j=1}^{N} \frac{(Y_j - C_j)}{(1+r_j)^{j-1}} = \sum_{j=1}^{N} \frac{S_j}{(1+r_j)^{j-1}} = \sum_{j=N+1}^{L} \frac{C_j}{(1+r_j)^{j-1}}.$$

It is clear from the above result that the present value of life-cycle savings depends on the relative lengths of the working and retirement periods (N and $L-N$, respectively), the shapes of age profiles of income and consumption, and the interest rate.

For further quantification, we impose some restrictions on the age profiles of income and consumption. More specifically, we assume that income and consumption expenditures in the working and retirement periods are constant at their average levels, denoted by Y, C_W and C_R, respectively, where subscripts W and R denote the working and retirement periods. That is, $S_j = S$ and $C_j = C_W$ for $j =$ 1 to N, and $C_j = C_R$ for $j = N+1$ to L.[6] We denote the ratio of C_R to C_W as α, that is $C_R = \alpha C_W$. Finally, we assume that the expected rate of return to savings is constant at a level of r. These assumptions, of course, are not realistic, and will lead to an inaccurate estimate of the life-cycle saving rate in terms of its level. Since our major concern is the effect of a changing expected length of retirement on the time trend of the life-cycle saving rate, imposing these restrictions does not greatly influence the results.

[5]This model is a modified version of the life-cycle model by Modigliani and Brumberg (1954). Unlike their model, income and consumption are allowed to vary over the life-cycle. In addition, the effect of a change in the interest rate is explicitly taken into account.

[6]If people allocate their savings for retirement evenly over the life-cycle, making the age-profiles of income and consumption move together, the constant savings in such a simplified model ($S = Y - C_W$) should be a close approximation of the actual magnitude of savings at each age (S_j). This assumption is consistent with the empirical findings that household income and consumption profiles move in a similar manner (Carroll and Summers, 1991; Deaton, 1991; Deaton and Paxon, 1993).

Under the above assumptions, the budget constraint in equation (2) is reduced to:

$$\text{(3)} \qquad S\left[\sum_{j=1}^{N}\frac{1}{(1+r)^{j-1}}\right]=C_R\left[\sum_{j=N+1}^{L}\frac{1}{(1+r)^{j-1}}\right]=\alpha C_W\left[\sum_{j=N+1}^{L}\frac{1}{(1+r)^{j-1}}\right]$$
$$=\alpha(Y-S)\left[\sum_{j=N+1}^{L}\frac{1}{(1+r)^{j-1}}\right].$$

From equation (3), we have the following result on the individual saving–income ratio, s:

$$\text{(4)} \qquad s=\frac{S}{Y}=\frac{\alpha\left[\sum_{j=N+1}^{L}1/(1+r)^{j-1}\right]}{\left[\sum_{j=1}^{N}1/(1+r)^{j-1}\right]+\alpha\left[\sum_{j=N+1}^{L}1/(1+r)^{j-1}\right]}.$$

Since by assumption people save a constant fraction of their income over the working period, the saving–income ratio suggested in equation (4) shows the proportion of income saved for retirement over the entire working period, as well as at each age. This saving–income ratio will be referred to as *the* (*individual or cohort*) *life-cycle saving rate*. In this simple model, the life-cycle saving rate of a cohort is determined by the three parameters, namely, the expected length of retirement relative to the length of the working period, the ratio of consumption in retirement to consumption in the working period (α), and the interest rate. That is, the longer the retirement duration ($L-N$) relative to the length of working period (N) and the greater the average consumption expenditure in retirement (C_R) relative to that while in the work force (C_W), the larger the proportion of income saved for retirement.[7] A rise in the interest rate would reduce the savings–income ratio required for the target amount of retirement savings, owing to increased interest income.

Let us now consider a year-specific, rather than cohort-specific, measure of the relative importance of life-cycle saving, which is defined as the ratio of the aggregate annual saving arising from life-cycle accumulation to the aggregate annual income in a particular year. This ratio will be called *the aggregate life-cycle saving rate* hereafter. This measure can be calculated based on the cohort-specific life-cycle saving rate suggested above. Here, the life-cycle saving rate of a cohort is assumed to be constant across different years. Therefore, the aggregate

[7]If C_R and C_W are the same (that is, $\alpha = 1$) this model is reduced to the stripped-down Modigliani–Brumberg model, where the proportion of income to be saved for retirement is $(L-N)/L$. C_R and C_W do not appear to be the same, however. The actual age-consumption profile shows that on average retired people consume less than those in the work force. Food consumption should be smaller for an older retiree than for a younger worker, for example, because the size of energy requirement for a worker depends upon his/her age and type of activity (Fogel, 1993, pp. 7–13). Labor force participation would also require fixed and variable costs of work (see Cogan (1981) for an example). Low consumption of the elderly might be attributed to the fact that marginal utility of expenditure is low at older ages. It might also be the case that consumption and leisure are substitutes (Deaton, 1992, p. 5).

life-cycle savings rate in a certain year (s_t) may be defined as the weighted average of the fixed life-cycle savings rate of each cohort ($s_{t,k}$):

$$s_t = \sum_k \omega_{t,k} s_{t,k}. \tag{5}$$

The weight of a cohort (ω_k) is determined by the relative share of the income earned by the cohort in a given year. This aggregate life-cycle saving rate is determined by the following factors: the patterns of mortality, fertility, retirement, consumption and productivity growth, long-term interest rate, and labor market conditions. The patterns of mortality, retirement, and age-consumption profile, and the interest rate determine the expected length of retirement and thus the cohort life-cycle saving rate, as explained above. Shifts in mortality and fertility affect the aggregate life-cycle saving rate because this changes the relative size of each cohort. If younger households in their accumulation phase account for a larger share of the population and retired dissavers account for a smaller share then the aggregate life-cycle saving rate would be greater. Also, the pattern of productivity growth and the labor market conditions would affect the relative income share of each cohort. Younger cohorts have larger lifetime resources than older ones as a consequence of rapid productivity growth and, therefore, their savings are larger than the dissavings of the poorer, retired cohorts. Similarly, favorable labor market conditions for young workers would have the same effect.

The parameters of the aggregate life-cycle saving rate other than the expected length of retirement are determined in the following manner. I estimate the ratio α using micro-samples of the Cost of Living Surveys of 1888–90 and 1917–19, the Survey of Consumer Expenditures of 1972–73, and the Consumer Expenditure Survey of 1994 (US Department of Labor, BLS). According to the estimate, a couple when retired need about two-thirds of the amount consumed while in the labor force. This ratio has been stable throughout this century.[8]

For the real rate of return to retirement savings, 1.5 percent was selected based on the long-term average real interest rates for various low-risk securities which range from 1 to 2 percent.[9] I also apply various interest rates ranging from 0 to 3 percent to determine the sensibility of the results to the choice of interest rate. The weight of each cohort is calculated using its relative population reported in US Department of Health and Human Services (1992b), and income estimated from IPUMS of the 1940–90 censuses and household income and expenditure surveys prior to 1940.[10]

Using the period and the cohort estimates of ELR, two different estimates of the aggregate life-cycle saving rate, the *period* and *cohort rates*, are derived.

[8]The estimate of α is 0.71 for 1888–90, and 0.67 for 1917–19, 1971–72 and 1994. See Lee (1996, Appendix B) for details of the estimation method.

[9]These securities include long-term government bonds (1.12 percent for 1900–90), long-term corporate bonds (2.00 percent for 1900–90), commercial paper (1.56 percent for 1900–90), Treasury Bills (0.75 percent for 1920–90), and pensions (1.44 percent for 1950–80). The average of the annual stock yields for 1900–90 is 1.62 percent. The sources for the returns to various assets are Homer and Sylla (1996), Shiller (1989), Hu (1985, p. 221), and US Bureau of the Census (1975, X479 and X483). Kotlikoff and Summers (1981) suggest that the real annual rate of return in the US economy averaged 4.5 percent between 1900 and 1974. The rate of return to retirement savings, however, may be lower than this estimate because people tend to invest in low-risk assets for the purpose of old age security.

[10]The method of determining the weight for each cohort is explained in Lee (1996, Appendix C).

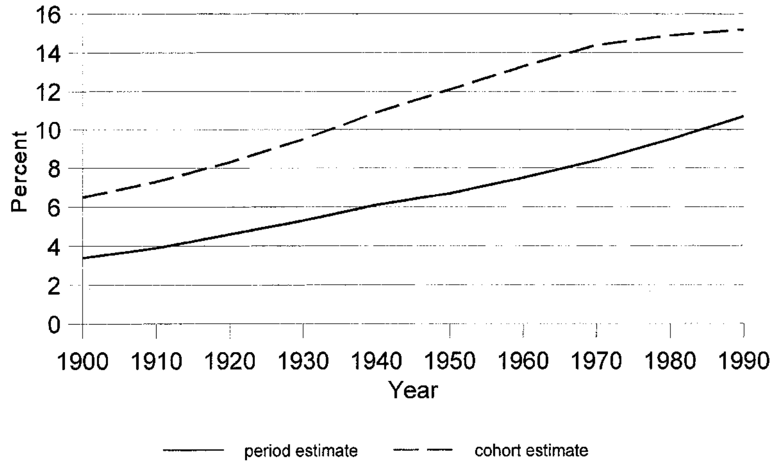

Figure 1. Aggregate Life-Cycle Saving Rates

Figure 1 shows these estimates for the period between 1900 and 1990, both based on an interest rate of 1.5 percent. Several features stand out from the trend. The fraction of income that was saved for retirement increased greatly over the last century. The average of the period and cohort rates nearly tripled between 1900 and 1990.[11] The cohort rate was well above the period rate throughout the period under investigation, indicating that expectation formations are an important determinant of the magnitude of retirement savings. Though not reported here, the results for many other interest rates suggest that the absolute size of the aggregate life-cycle saving rate is quite sensitive to the choice of interest rate. For instance, an increase in the interest rate by 2 percentage points reduces the estimate of the aggregate life-cycle saving rate by one third. However, the rate of change of the aggregate life-cycle saving rate over time does not depend much upon the choice of the interest rate.

4. Long-Term Trend of the Relative Importance of Life-Cycle Saving

Let us now turn to the question of how the relative importance of life-cycle saving changed over time. For this purpose, I compare the trend of the aggregate

[11]The time trend in the counterfactual savings rate reflects the changes in the life-cycle savings rate and the weight of each age group. The rise in the counterfactual life-cycle savings–income ratio is entirely attributable to the growth of the ELR over time. The weight of each age group changed over time in a direction that reduces the aggregate life-cycle savings rate. As the population got older on average and the slope of age–income profile became steeper, the weight of young men fell while that of older men grew over time. Since the proportion of income to be saved for retirement is greater for younger men than the elderly, the bigger the weight of older cohorts the lower will be the aggregate counterfactual savings rate. Mortality decline and the fall in labor force participation were equally important in accounting for the increase in the length of retirement between 1900 and 1940. After 1940, on the other hand, mortality decline was the dominant factor of the growth of the retirement duration. See Lee (1996, Chapter 3) for further details on method and results of the decomposition of the growth of ELR.

life-cycle saving rate, estimated above, with the trend of the actual aggregate household saving rates. Table 2 reports the ten-year averages of various household saving rates between 1900 and 1990. The first two saving rates (columns 1 and 2) are based on the conventional definition of saving employed in the National Income and Product Accounts (NIPA). The first column reports the personal saving rate (ratio of personal savings to disposable income), which is probably the most widely used measure of the household saving rate. The next column presents the private saving–income ratio (ratio of personal savings plus

TABLE 2

ACTUAL PRIVATE SAVINGS–INCOME RATIOS, 1900–90 (10-YEAR AVERAGE, PERCENT)

Year	(1) Personal Saving	(2) Private Saving	(3) Saving in Public Funds	(4) Durables Saving	(5) Broadly-defined Private Saving 1	(6) Broadly-defined Private Saving 2
1900	9.9	12.6	0.0	2.4	12.6	14.9
1910	10.1	13.8	0.0	1.7	13.8	15.4
1920	12.9	12.4	0.0	1.7	12.4	14.4
1930	4.1	1.4	0.4	−0.3	1.6	1.3
1940	12.6	15.1	1.4	0.5	16.2	16.7
1950	6.7	12.1	2.0	3.7	13.8	17.2
1960	6.0	9.9	4.1	1.0	13.4	14.4
1970	7.2	10.9	7.5	2.0	16.8	18.6
1980	6.5	10.3	10.0	1.2	18.2	19.2
1990	4.3	6.6	12.1	1.7	16.5	17.9

Definition and source:

(1) The ratio of personal savings to disposable personal income. Annual data on personal savings and income were collected from US Bureau of the Census (1975, F6–9; F543; F553) for 1897–1970, and various editions of *Statistical Abstract of the US* for 1971 to 1993.

(2) The ratio of private savings (personal savings + undistributed corporate profits) to private income (disposable personal income + undistributed corporate profits). The annual data on corporate profits for 1929 to 1990 were collected from the US Bureau of the Census (1975, F183) for 1929–70, and various editions of *Statistical Abstract of the US* for 1971–93. The figures for 1900 to 1920 were calculated from the 10-year averages of private savings–income ratios as of 1890–99, 1900–09, 1910–19, and 1920–29, reported in Darby (1979, p. 25).

(3) The ratio of savings in public funds (contributions to the social security trust funds and the government employee pension funds) to disposable personal income. The contributions to the social security trust funds include the net contributions to the Old-Age, Survivors and Disability Insurance (OASDI) and the Medicare (Hospital and Supplementary Medical Insurance). The data used in the computation are from the US Department of Health and Human Services (1990, pp. 129–30; 263–64) for 1937–89, and the US Bureau of the Census (1994, 375 no. 581) for 1990–92. The sources for the contributions to the government employee pension funds are Hendershott and Peek (1989, p. 202) for 1950–85, and the US Bureau of the Census (1994, 378, no. 584) for 1986–92. The data for 1929–49 are estimated assuming that the growth rate of the contributions was the same as that of the expenditure. The source for the expenditure on public employee pensions is the US Bureau of the Census (1975, 340, H8).

(4) The ratio of the net purchases of consumer durables (measured by the increase in the net stock of consumer durables) to disposable personal income. The data for durables are from Goldsmith (1962, p. 188) for 1900, 1912, 1922, 1933 and 1939, the US President (1992, p. 422) for 1945–90, and the US Bureau of the Census (1994, 483, no. 745) for 1991.

(5) The ratio of private savings plus savings in public funds (contributions to the social security trust funds and the government employee pension funds) to the sum of disposable personal income, undistributed corporate profits, and savings in public funds.

(6) The ratio of the sum of private savings, savings in public funds, and the net purchases of consumer durables to the sum of disposable personal income, undistributed corporate profits, and savings in public funds.

undistributed corporate profits to disposable income plus undistributed corporate profits). The rationale for aggregating household and corporate savings is that personal and corporate savings may be perfect substitutes (David and Scadding, 1974; Shafer, Elmeskov, and Tease, 1992).

Numerous studies have pointed out the potential defects of estimating saving rates based on the NIPA (Blades and Sturm, 1982; Auerbach, 1985; Holloway, 1989; Hendershott and Peek, 1989). For the purposes of this study, the exclusion of public savings of households is particularly troublesome. Household retirement transactions with the private sector are accounted for correctly in the computation of saving in the NIPA. However, contributions to a government retirement plan or social security are not included in personal income and thus are not counted as saving. Since the social security and public retirement plans serve as a means of retirement saving just as private pensions, it makes little sense to treat them differently in computing the saving rate. Another potential problem with using the NIPA definition of saving is that the entire expenditure on household durables is regarded as consumption. Since durables provide future consumption service, it is more reasonable to assume that at least a part of their purchase represents a form of saving.

More broadly defined private saving rates are computed to remedy these conceptual problems. The size of the saving in public funds (defined as the contributions to the social security trust funds and government employee pension plans) and of durables-saving (defined as the net purchase of consumer durables), measured as a percentage of disposable personal income, is given in columns 3 and 4. In column 5, an alternative private saving rate is reported that incorporates saving in public funds to income and saving. The final column presents an even more inclusive private saving rate in which both saving in public funds and durables-saving are added to saving and income. Although Table 2 does not offer an exhaustive list of actual household saving rates, I believe it suggests a reasonable range of the household saving–income ratio.

As regards the personal saving rate, the actual household saving rate was found to be stable between 1900 and 1940, except during the era of the Great Depression when saving rates were extremely low, and started to decline thereafter (column 1). If the private saving rate is considered, the household saving rate exhibits no clear long-term tendency during the 20th century, although it has declined considerably in recent years (column 2). The more broadly defined household saving rates, on the other hand, show a modestly increasing trend (columns 5 and 6) mainly due to the rise in the fraction of income that was contributed to public pension funds after 1940 (column 3). The inclusion of durables saving substantially increases the level of the actual saving rate, particularly for 1950. However, it is not a major factor of the overall trend of the saving rate.[12] In sum, the household saving rate in the

[12]Investment in real estate may be another important type of wealth accumulation for households. The net investment in owner-occupied real estate (measured by the increase in the net worth of owner-occupied real estates held by households and non-profit institutions) was about 4.4 percent on average of disposable personal income between 1945 and 1990 (US President, 1992, p. 422). A similar figure (the ratio of the increase in the value of non-farm residential structures and land to disposable personal income) for 1897–1929 was about 2 percent. If the entire part of this investment is added to saving, the time trend of the actual household saving rate remains basically unaffected.

US stagnated or increased only modestly during the 20th century, depending on the definition of saving.

I suggested above that the ratio of life-cycle saving to income rose about three times over the last century. These trends of the aggregate life-cycle and total household saving rates indicate that the relative importance of life-cycle saving in wealth accumulation is much greater today than it was a hundred years ago. If the household saving–income ratio was stable, as indicated by the saving rates based on the NIPA, then the proportion of household saving accounted for by life-cycle accumulation increased three times between 1900 and 1990. Employing an alternative definition of household saving does not change the story much. The broadly defined private saving rates, in which contributions to public funds are considered, increased at a much slower pace than did the aggregate life-cycle saving rate (column 5 of Table 2). Even if 1980 is chosen as the bench-mark year, when the actual saving rate peaked, the overall growth rate of the total household saving rate since 1900 is only 44 percent, as compared to a 300 percent increase in the aggregate life-cycle saving rate. In this case, the share of life-cycle saving in the total household saving more than doubled during the period under study. All in all, the proportion of household saving that represents life-cycle wealth accumulation increased dramatically, perhaps two to three times, over the 20th century.

The result of this study raises a question: why did the aggregate household saving rate remain stable or increase only modestly in spite of the dramatic rise of the life-cycle saving rate? It is beyond the scope of this paper to answer this question. A possible, though speculative, explanation is that saving from other motives, especially from the precautionary motive, declined over time, offsetting the increase in saving for retirement. It is well documented that individuals may develop a precautionary motive for savings when faced with uncertain future income (Leland, 1968; Sandmo, 1970; Skinner, 1988; Zeldes, 1989; Kimball, 1990; Caballero, 1991; Hubbard, 1995). The degree of income uncertainty should have been reduced over the last century thanks to the implementation of a wide range of social insurance programs, including social security, unemployment insurance, workers' compensation, and government-subsidized health care (Cutler and Gruber, 1995; Hubbard, Skinner, and Zeldes, 1995; Kantor and Fishback, 1996). There is another source of precautionary saving, namely, the uncertainty of people's lives. When annuity insurance is not available, a risk-averse householder might leave a positive wealth stock at the time of death to avoid the prospect of remaining alive in a state of poverty even if he has no bequest motive (Davis, 1981; Hubbard, 1984; Kotlikoff, Shoven, and Spivak, 1986). This type of precautionary motive for saving arising from an uncertain lifetime may have been reduced due to increased annuitization of income.

5. Conclusions

This paper has examined the long-term trend of the fraction of household saving that represents the life-cycle accumulation. I estimate the expected length of retirement for each labor market cohort between 1850 and 1990 based on their age-specific mortality and labor force participation rate. The result suggests that since 1850 the expected length of male retirement at age 20 has increased by more than six-fold, mainly due to the rise of life expectancy and the decline in labor force participation of older men. The cohort who entered the labor market in 1990 is expected to spend up to 30 percent of their remaining lives in retirement.

According to life-cycle models of consumption and labor supply, a longer retirement period relative to working period means a greater fraction of lifetime income to be saved for retirement. I estimate that the ratio of life-cycle saving to income tripled between 1900 and 1990. Meanwhile, various measures of the actual household saving–income ratio stagnated or grew only modestly during the 20th century. This implies that the size of life-cycle saving, relative to the entire wealth accumulation of households, has increased over time. I estimate that the fraction of household saving accounted for by life-cycle accumulation is two to three times as large today as it was a hundred years ago.

The existing literature largely focuses on the question of "what percentage of the US wealth stock resulted from life-cycle savings?" This paper provides only limited implications for this issue. However, the present study suggests that even a correct answer to the above question will not reveal the relative importance of retirement saving *at a given point of time*, because the relative size of life-cycle saving kept changing over time. It is unclear why the aggregate household saving rates remained stable in spite of the huge increase in the life-cycle savings. A possible explanation is that precautionary saving declined over time due to the development of various social insurance programs and increased annuitization of income during the last century. Further studies on this issue should sharpen our understanding of the long-term trend of US household savings.

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