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ABSTRACT

We examine optimal retirement saving for young adults in a life cycle model. We find that for liquidity-constrained young adults who anticipate significant earnings growth, optimal retirement saving is zero. Specifically, we find that with a plausible wage profile for college-educated workers, retirement saving does not begin until the late 30s or early 40s, even with standard employer matching. In fact, inducing workers in their mid 20s to participate in a retirement plan requires employer match rates of more than 1000 percent. In contrast, workers facing a flat wage profile begin saving much earlier in life. We also find that participating may be optimal for younger workers facing steeper wage profiles if they anticipate switching jobs and cashing out after 1-2 years. Our results suggest that automatically enrolling workers, regardless of age or anticipated future earnings, in defined contribution plans is not consistent with optimizing behavior in a life cycle model.

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I. Introduction

Young adults are less likely than other age groups to participate in employer-sponsored defined contribution plans like 401(k)s, and those who do participate choose lower contribution rates than older workers (Vanguard 2020). Moreover, when they switch jobs, young workers are more likely than other age groups to cash out of their 401(k) plans (Munnell and Webb 2015). Such leakages from retirement accounts are widely viewed as a problem (Tergesen 2017; VanDerhei 2019). More broadly, there has been widespread concern about the adequacy of retirement saving (see, for example, Gomes, Hoyem, Hu and Ravina 2018). Explanations for why individuals may fail to save adequately for retirement have drawn on behavioral economics (Attanasio and Weber 2010 provide a review), and solutions to this problem have generally focused on boosting saving at all stages of the life cycle. For example, the number of 401(k) plans with automatic enrollment has tripled since 2007 (Vanguard 2020). Automatic enrollment greatly boosts participation rates in 401(k)s, with a particularly pronounced effect among young adults (Madrian and Shea 2001).

In this paper, we examine the extent to which young workers' reluctance to participate in defined contribution plans – even with generous employer matching – can be explained within a life-cycle model with rational, optimizing behavior. We find that a standard life cycle model predicts zero or low retirement saving at younger ages under a variety of plausible conditions. In particular, there are three factors that can rationalize zero retirement saving for workers in their 20s, even with generous employer matches. First, in the presence of borrowing constraints, a relatively steep earnings profile (typical of higher-income workers) can make zero saving at younger ages optimal. Second, near-zero real interest rates (which have prevailed for the past decade) lower the cost of current consumption relative to future consumption, making a consumption profile that declines with age optimal and leading to lower saving for plausible parameter values. Finally, as our previous research has shown (Scott, Shoven, Slavov and Watson 2020), a high Social Security replacement rate (typical of lower income workers) can rationalize lower saving at all ages.

We explore the contribution of the first two factors to rationalizing low saving among college educated younger workers. Our findings suggest that if the real interest rate is 3 percent, the same as the subjective rate of time preference, and the earnings profile is flat, retirement saving begins immediately upon commencing work. That is, under these assumptions, young workers save for retirement in a standard life cycle model. When the real interest rate is zero percent (in line with recent experience), and the earnings profile is flat, the onset of saving is delayed to age 30 with a typical employer match, and 38 without. That change reflects the desirability of a declining consumption profile due to the fact that the subjective rate of time preference exceeds the real interest rate. A more realistic earnings profile – in which earnings for young and middle-aged workers rise with age – delays the onset of saving regardless of whether interest rates are high or low. With a 3 percent interest rate, saving for retirement commences at age 37 with an employer match and 40 without; with a zero percent interest rate, saving for retirement commences at age 41 with an employer match and 44 without. This shift – even at a higher interest rate – reflects the upward sloping earnings profile combined with a borrowing constraint. The individual would like to borrow against future wages to finance steady consumption but is unable to do so; thus, consumption tracks earnings initially and retirement saving begins later in life. The lower interest rate pushes the onset of saving even further into the future as the ideal consumption path is now downward sloping.

Our findings have implications for the design of automatic enrollment features in defined contribution retirement plans. These features are introduced with the idea that they will nudge workers to participate in the plan. It is assumed that enrolling is in the participant's self-interest (particularly for plans with matching contributions) and that failure to enroll reflects a non-optimizing mistake. However, optimality is often defined by a standard life-cycle model with rational behavior. If one's labor market earnings at age 25 are only 42 percent of peak earnings at age 45 or 50 (typical for college graduates), not saving for retirement in the early years of one's career may be completely optimal and rational in a life-cycle model. In such a model, life cycle considerations lead one to a consumption profile that is smoother than the earnings profile and saving for retirement when income is temporarily low could be suboptimal. If a life cycle model represents optimal behavior, then automatic enrollment that applies to workers of all ages could be nudging young people to make – rather than avoid – a mistake. Related work by Harris, Troske, and Yelowitz (2018) examines the optimality of retirement saving for individuals with high levels of credit card debt.

Our life cycle model is the simple, standard framework that economists use to address saving and wealth accumulation over a lifetime. Additional institutional richness could overturn the conclusion that the typical college graduate would optimally not start saving for retirement until their late 30s or early 40s. After presenting the model and results, we provide a discussion of additional considerations that could alter the conclusions. But our findings from the simple model can contribute to examination and exploration of the logic and design of automatic enrollment.

II. Model

a. Basic Problem

We begin with a standard life cycle model in which an individual who begins working life at time 0 and live for up to T years. Labor is supplied inelastically through an exogenous retirement age, at which point Social Security is claimed. Each period, the individual has the opportunity to save a in a tax-deferred employer-sponsored retirement account (with an employer match) and in a taxable brokerage account. The individual solves the following problem:

$$V_* = \max \sum_{t=0}^{T} \alpha_t U(C_t)$$

subject to

$$A_{t+1}^{B} = R_{t+1}^{B}(A_t^{B} + \Delta_t^{\mathrm{B}})$$

$$A_{t+1}^{D} = R_{t+1}^{D}(A_t^{D} + \Delta_t^{\mathrm{D}} + m_t)$$

$$C_t = B_t - (\Delta_t^{\mathrm{B}} + \Delta_t^{\mathrm{D}})$$

$$C_t \geq 0$$

$$A_t^{B} \geq l_t$$

$$A_t^{D} \geq 0$$

$$\epsilon_t \leq \Delta_t^{\mathrm{D}} \leq \gamma_t$$

Here, C_t represents consumption in period t and α_t is a discount factor that incorporates both a pure rate of time preference and a survival probability. B_t is income, including labor and Social Security income. A_t^B and A_t^D, respectively, are assets in the brokerage account and tax-deferred retirement account. R_{t+1}^B and R_{t+1}^D, respectively, are the gross returns on the brokerage account and the tax-deferred retirement account. We allow for the differences in the interest rate on saving and borrowing, as discussed below. Δ_t^{B} and Δ_t^{D}, respectively, are contributions to the brokerage account and the tax-deferred retirement account. Employer contributions to the retirement account are denoted m_t. Assets in the brokerage account cannot fall below a borrowing limit, l_t. The upper and lower bounds on Δ_t^{D}, contributions to the retirement account, are used to enforce contribution limits and required minimum distributions, as described below.

b. Borrowing costs

In the taxable account, the interest rates for borrowing and saving may be different. We model this by splitting an account's value into positive and negative parts and then applying the correct rate to each part. For example, let $u_t \geq 0$ be the positive part and $v_t \geq 0$ be the negative part, then

$$A_t^B + \Delta_t^B = u_t - v_t$$

$$A_{t+1}^B = R_{t+1}^{B,save} u_t - R_{t+1}^{B,borrow} v_t$$

The non-negative parts u_t and v_t must obey the complementarity condition $u_t v_t = 0$. That is, only one of the parts may be positive. If the interest rate on borrowing is greater than the interest rate on saving, we can reasonably expect that complementarity will hold – i.e., there will be no arbitrage opportunities where the individual can borrow at a lower rate and invest the borrowed funds to earn a higher return. When we solve the problem, we replace the complementarity conditions with simple non-negativity constraints ($u_t, v_t \geq 0$), optimize, and verify that complementarity holds for the result.

c. Limits on Tax-Deferred Transactions

There are limits on the contributions an employee may make to a tax-deferred account. Also, there are Required Minimum Distributions (RMDs) that a retiree must take when she reaches age 72. An employee's yearly contribution (withdrawal) to (from) her tax-deferred account is Δ_t^{D}. In order to easily distinguish between a contribution and a withdrawal, we split Δ_t^{D} into positive and negative parts, where $u_t' \geq 0$ is the positive part or contribution and $v_t' \geq 0$ is the negative part or withdrawal. That is,

$$\Delta_t^D = u_t' - v_t'.$$

These parts must obey a complementarity condition $u_t' v_t' = 0$. If we assume that an individual may only contribute funds during her working years and may only withdraw funds during her retirement years, then complementarity is automatically satisfied. During working years, we require

$$0 \leq u_t' \leq K_t$$

where K_t is the contribution limit. In any year, a retiree may withdraw any amount that exceeds the RMD, but no more than the account's value. Thus, during retirement years, withdrawals must satisfy

$$L_t \leq v_t' \leq A_t^D$$

where L_t is the RMD and requires individuals aged 72 or older to withdraw a fraction f_t of the account value:

$$L_t = \begin{cases} 0 \; if \; age(t) < 72 \\ f_t A_t^D \; if \; age(t) \geq 72 \end{cases}$$

d. Matching

Many employers offer their employees a 401(k) match. These programs may either partially or fully match employee contributions. The majority of employer matching programs are summarized by a simple formula. Let m_t be the employer match, i.e., the actual dollar amount contributed by an employer, and let W_t be the employee's salary. Recall that Δ_t^{D} is the employee contribution and K_t is the employee contribution limit. Then

$$m_t = k_1 \min(\max(0, \Delta_t^{\mathrm{D}}), \min(k_2 W_t, K_t)).$$

Here, an employee's contribution is matched at the rate k_1 up to the IRS's limit or a fraction k_2 times the employee's salary, whichever is less. A commonly used partial match program matches 50% of contributions up to 6% of salary, i.e., $k_1 = 0.5$ and $k_2 = 0.06$. A typical full match program has parameters $k_1 = 1$ and $k_2 = 0.04$. If we add in the employer's match, the tax-deferred account value evolves as

$$A_{t+1}^D = R_{t+1}^D (A_t^D + \Delta_t^D + m_t)$$

Note that for withdrawals, we have $\Delta_t^D < 0$, which implies $m_t = 0$.

The match m_t is a piecewise linear function of u_t', the positive part of Δ_t^D. In particular,

$$m_t(u_t') = \begin{cases} k_1 u_t' \; if \; 0 \leq u_t' \leq M_t \\ k_1 M_t \; if \; M_t \leq u_t' \leq K_t \end{cases}$$

where $M_t = \min(k_2 W_t, K_t)$. On the linear segment $u_t' \in [0, M_t]$, the function rises from the origin along the line with slope k_1. On the linear segment $u_t \in [M_t, K_t]$, the function is flat and hugs the horizontal line at height $k_1 M_t$.In solving the model, we do not need to explicitly enforce the logic that controls switching between linear segments. Rather, we can obtain the same results with the following constraints:

$$0 \leq \frac{m_t}{k_1} \leq M_t$$

$$\frac{m_t}{k_1} \leq u_t' \leq K_t$$

The first of these constraints limits the employer's match to the plan's maximum, and the second guarantees that the employee contributes as much as the employer, but no more than the contribution limit. Since the match is "free money," an optimization seeks as much as possible provided that the employee contributes first. Thus, one of three bounds on m_t will be binding: (1) $m_t = 0$, (2) $m_t = k_1 M_t$, or (3) $m_t = k_1 u_t'$.

e. Calibration

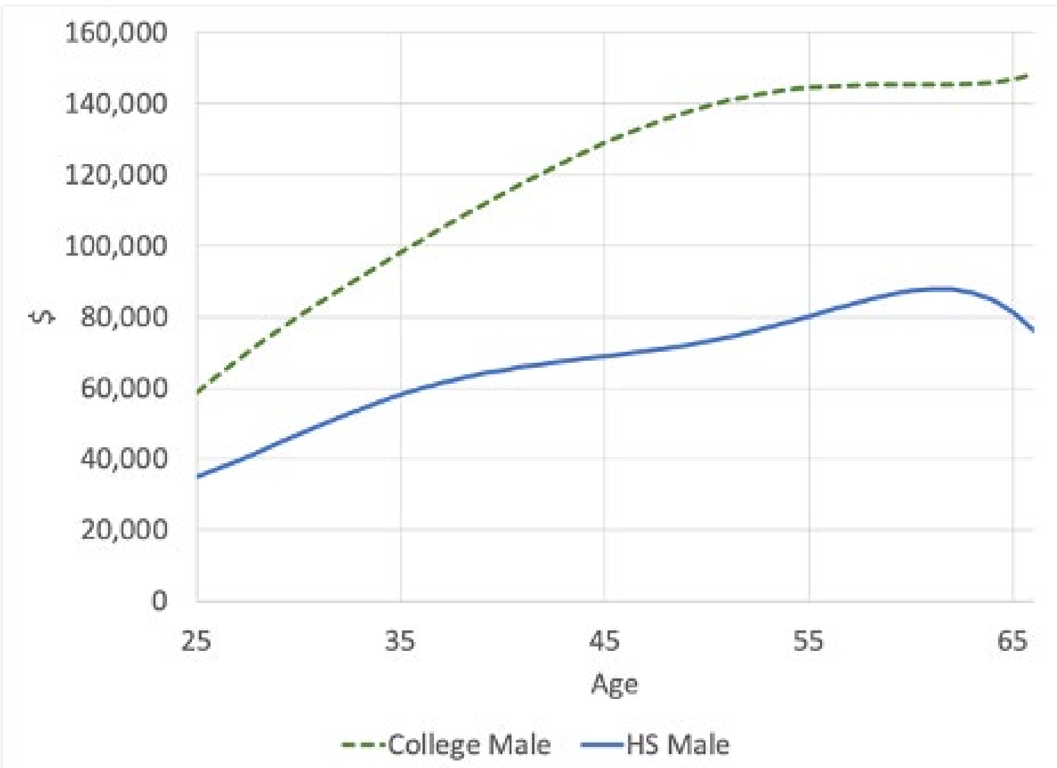
We consider males and females born in 1995 who start work at age 25 and can live through age 110. Survival probabilities come from the Social Security Administration cohort mortality tables underlying the intermediate assumptions in the 2013 Trustees Report. The pure rate of time preference is 3 percent. We use a utility function that exhibits constant relative risk aversion with a coefficient of relative risk aversion equal to 3. Retirement and Social Security claiming occur at age 67, the full retirement age for the cohort. The real interest rate on saving in the taxable account is set to either 0 percent or 3 percent. The average combined federal and state tax rate on wages is assumed to be 27 percent. Inflation is set to 2 percent. Contribution limits and required minimum distributions are based on IRS rules.[1] The employer match is assumed to bd 50 percent for up to 6 percent of wages. In our baseline analysis, borrowing is not allowed; however, after performing our baseline analysis, we consider how borrowing changes the results.

We construct a stylized wage profile for a college-educated individual using data from the Center for Economic Policy Research's Current Population Survey extract for March 2018. We begin by computing age profiles of average wage and salary income for individuals with a bachelor's degree. We then divide these averages by the Social Security Average Wage Index (AWI) in 2018 ($52,145.80). Thus, we obtain snapshots of the age-wage profile, relative to the economy-wide average wage, for our workers. We smooth these profiles by fitting a fifth-degree polynomial to them. We simulate wages in the model by multiplying the fitted ratios in Figure 1 by a future projection of the AWI, which is assumed to grow at 3 percent. Figure 1 shows our simulated wage profile for college-educated males; for comparison, we also include the profile for high school educated males. Compared to the wage profile for high school educated males, the wage profile for college-educated males grows more rapidly with age. In reality, more highly educated workers may benefit from faster economy-wide wage growth; that would make the wage profile for this group even steeper. College educated females have a somewhat flatter wage profile. In the remainder of the paper, we focus on males in order to illustrate the role that the shape of the wage profile play. Results for females are available upon

[1] See https://www.irs.gov/retirement-plans/plan-participant-employee/retirement-topics-401k-and-profit-sharing-plan-contribution-limits and https://www.irs.gov/retirement-plans/plan-participant-employee/retirement-topics-required-minimum-distributions-rmds.

request. Social Security benefits are calculated using the standard formula based on the highest 35 years of earnings indexed for wage growth.

Figure 1: Simulated Wage Profiles



III. Results

We begin by solving the model under the assumption of a 3 percent real interest rate and a constant wage equal to the average lifetime wage shown in Figure 1. This solution provides a benchmark for comparison so that we can explore the role of low interest rates and a steep wage profile. Next, we consider lowering the interest rate to zero percent – in line with recent experience – while keeping the wage profile flat. Then, we consider the more realistic wage profile shown in Figure 1, combined with a 3 percent real interest rate. Finally, we combine the wage profile shown in Figure 1 with a zero percent interest rate. For each case, we consider an employer match of 50 percent up to 6 percent of earnings, as well as no employer match. All dollar amounts shown in this section are in inflation-adjusted 2020 dollars.

a. High Interest Rate, Flat Wage Profile

Figure 2 shows the path of consumption, both with and without an employer match, when the interest rate is 3 percent and the wage profile is flat. The path of income is also shown as a dashed line. Consumption is slightly downward sloping through middle age and drops off at older ages. The subjective rate of time preference equals the interest rate; thus, the downward slope reflects mortality discounting. The figure indicates that consumption is below income through retirement; that is, saving begins immediately upon commencing work. An employer match shifts the consumption profile upwards at all ages, reflecting an income effect (which dominates the substitution effect of the subsidy for saving).

Figure 2: Optimal Consumption with 3 Percent Real Interest Rate and Averaged Wage Profile

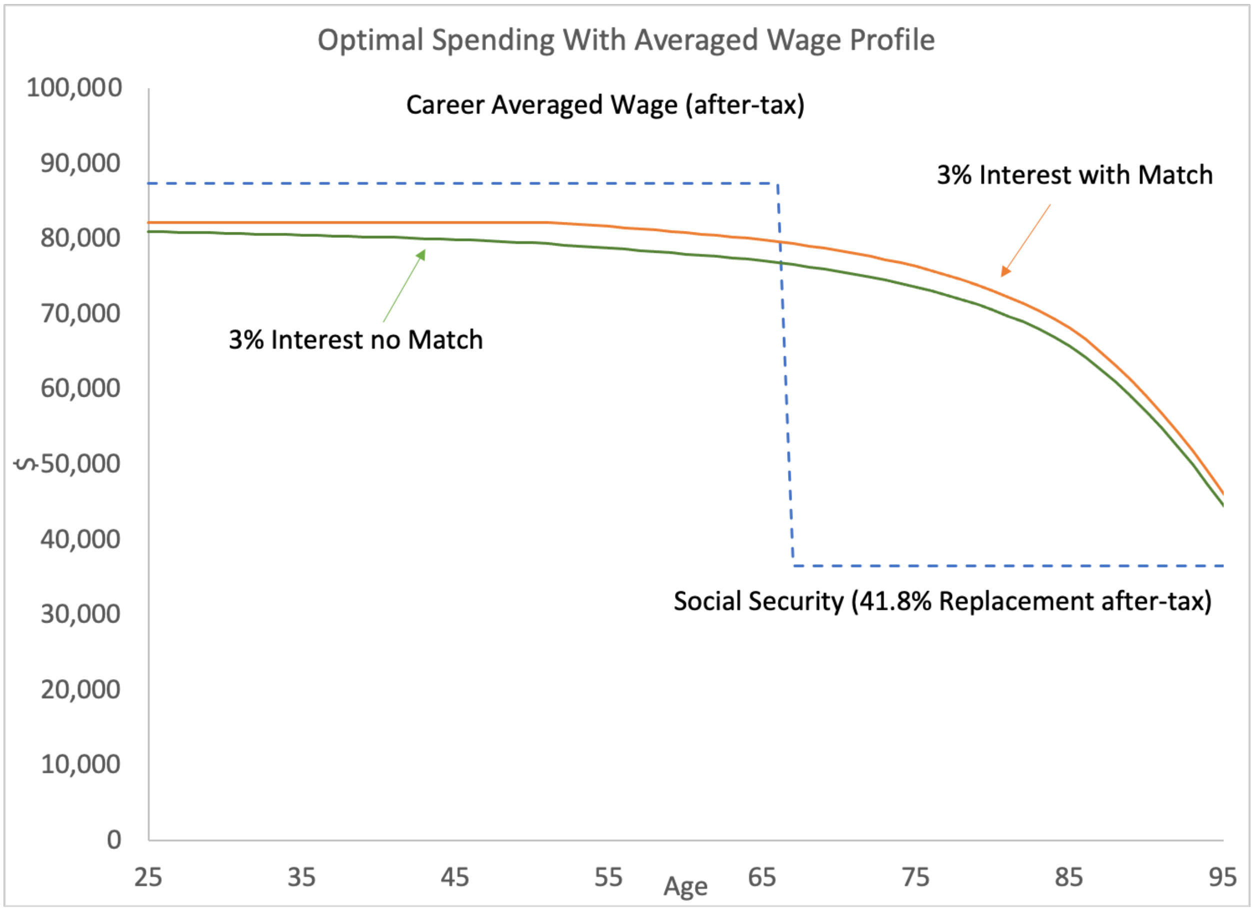


Figure 3 shows how a zero percent real interest rate affects the path of consumption both with and without an employer match. We continue to assume the wage profile is flat. Now consumption has a marked downward slope, reflecting the divergence between the subjective rate of time preference and the real interest rate (on top of mortality discounting). In this scenario, saving does not begin immediately – a result that is reflected in the fact that consumption initially tracks income. When the employer match is offered, saving begins at age 30; with no match, saving begins at age 38. Consumption with a match is initially below consumption without a match, reflecting the substitution effect of the match. However, the income effect ultimately dominates, and consumption is higher when the match is offered.

Figure 3: Optimal Consumption with 0 Percent Real Interest Rate and Averaged Wage Profile

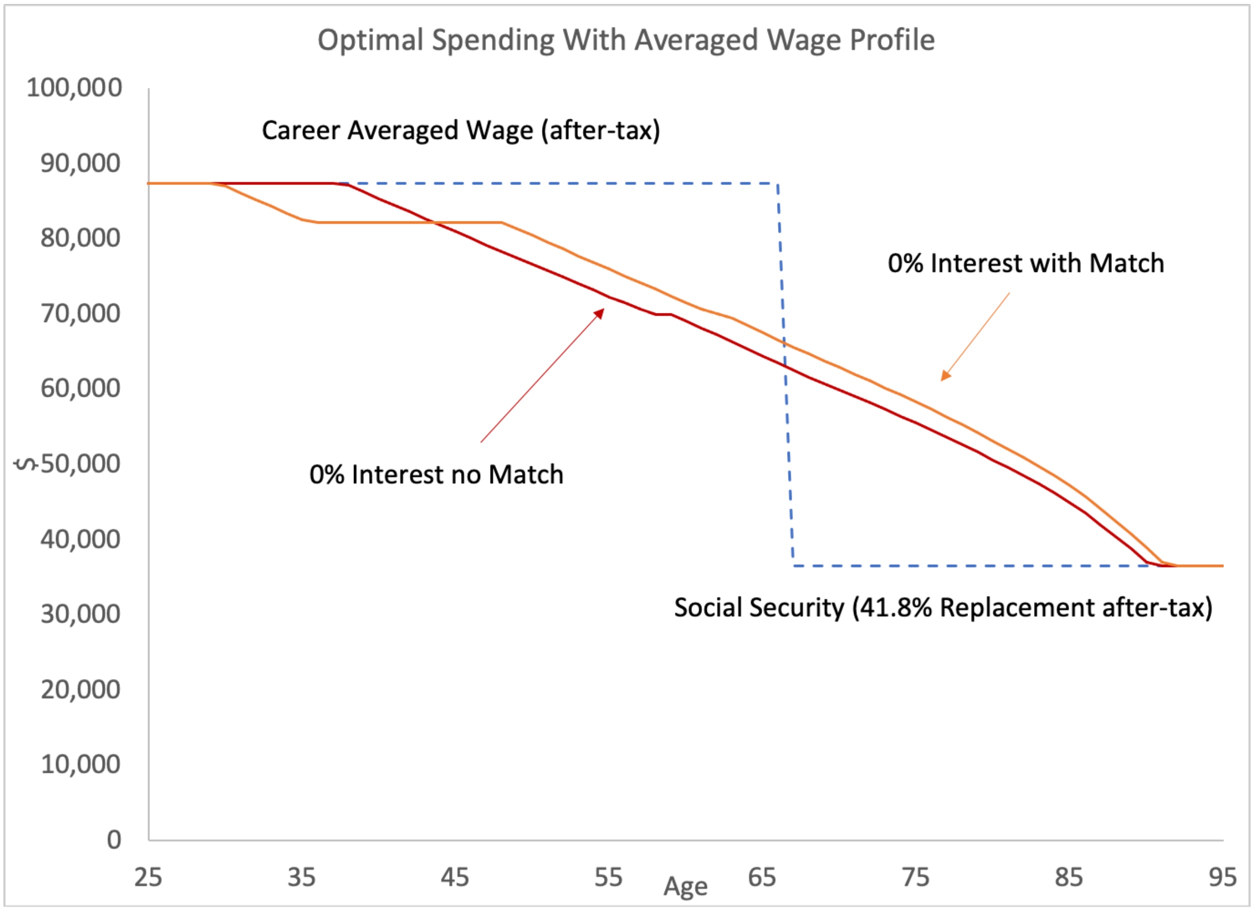


Figure 4 shows the path of consumption under the higher 3 percent real interest rate, but when the wage profile reflects the shape shown in Figure 1. In this scenario, the individual would ideally like to have the consumption profile shown in Figure 2; however, borrowing constraints combined with the steep wage profile make that infeasible. Thus, consumption initially tracks wages, and there is no retirement saving. Saving begins at age 37 with a match and age 40 without a match. Figure 5 combines the low interest rate assumption of Figure 3 and the realistic wage profile assumption of Figure 4. In this case, saving is delayed even further – to age 41 with a match and age 44 without a match.

Figure 4: Optimal Consumption with 3 Percent Real Interest Rate and Simulated Wage Profile

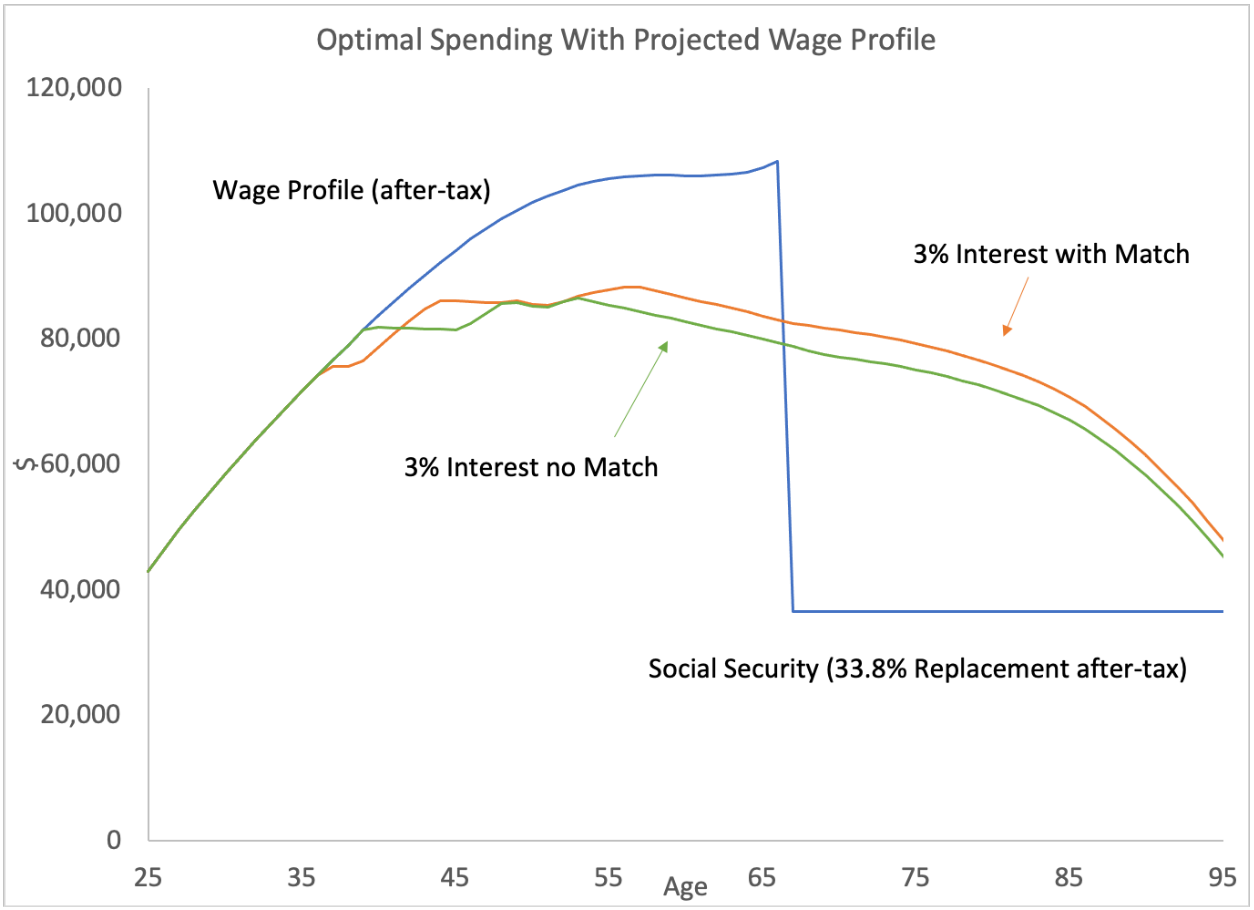
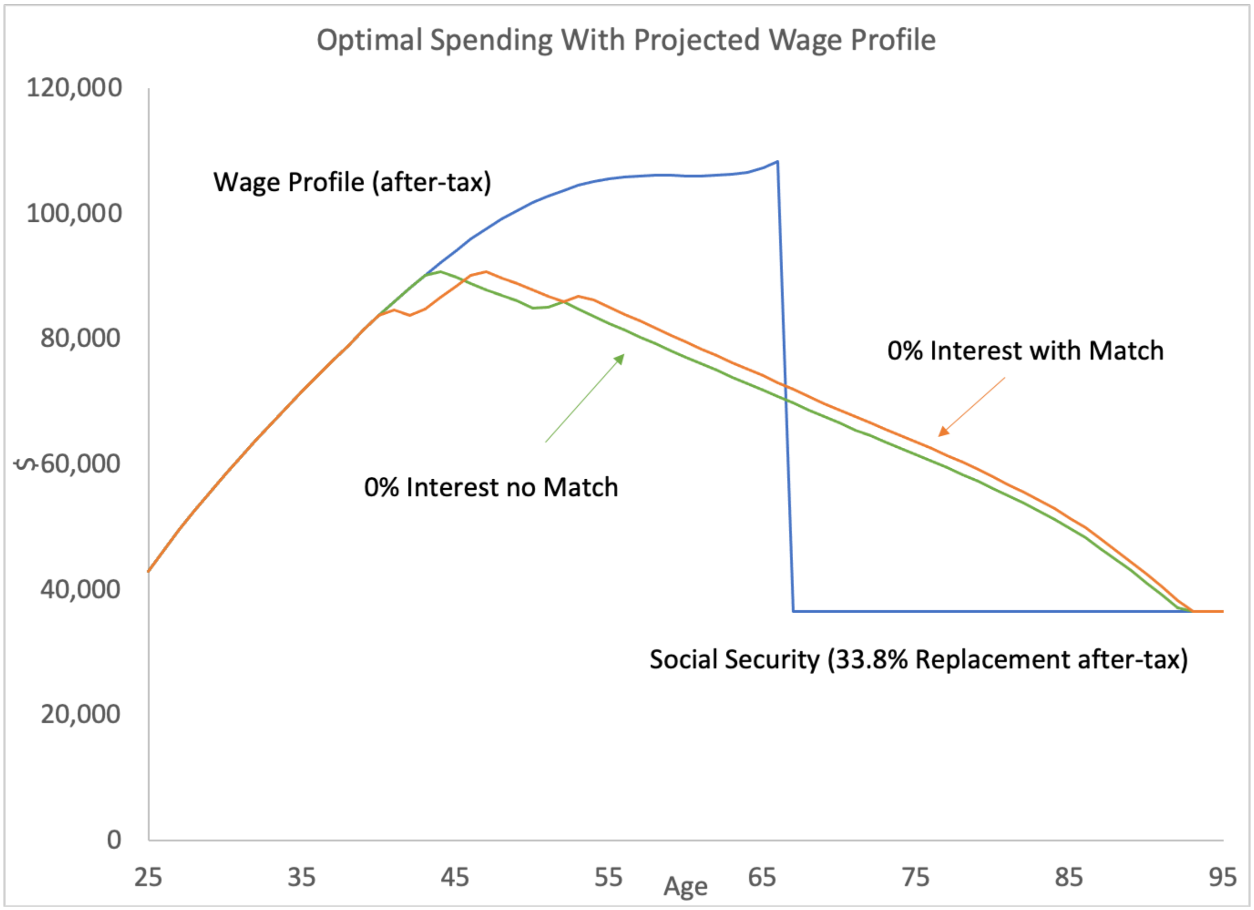


Figure 5: Optimal Consumption with 0 Percent Real Interest Rate and Simulated Wage Profile



b. Impact of Matching and Job Changes

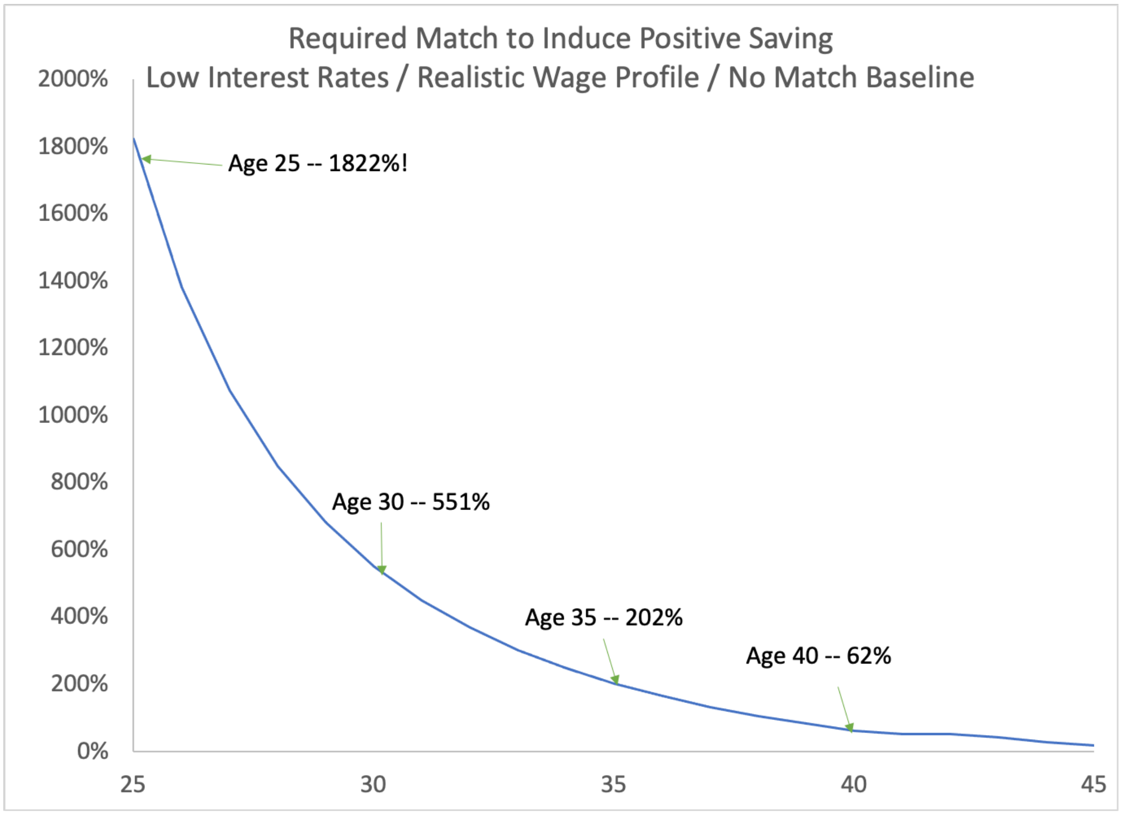
Our life cycle model predicts that young workers generally will not contribute to employer-sponsored retirement plans even with typical levels of employer matching contributions. Table 1 shows the age that saving begins under the four sets of assumptions reflected in Figures 2-4. When the wage profile is flat and the interest rate is 3 percent, saving begins at age 25 regardless of the presence of a match. Under all other sets of assumptions, saving does not begin immediately even with a match, although a match does bring forward the date at which saving begins. When interest rates are low and the wage profile is steep, saving does not begin until the 40s even with a standard employer match.

Table 1: Age at Onset of Saving

	Flat Wage Profile		Steep Wage Profile	
	Match	No Match	Match	No Match
High Interest Rates	25	25	37	40
Low Interest Rates	30	38	41	44

What match rates would induce younger workers to participate? Figure 6 shows the match rate required to induce participation at each age when the interest rate is zero percent and the wage profile has the shape shown in Figure 1. It suggests that match rates of 1000 percent or more are required to induce workers in their 20s to contribute. The required match rate drops steadily with age. In the early 40s, it reaches 50 percent – at which point the stylized worker is induced to save under the standard employer matching we use to generate Figure 5.

Figure 6: Employer Match Rates Required to Induce Nonzero Saving



Thus far, we have assumed that our stylized worker does not have the opportunity to cash out of the 401(k). What if the worker were offered the option to cash out with a 10 percent penalty after a specified period? Such opportunities may arise with job changes. Indeed, the option of cashing out after a few years accelerates the onset of saving. Table 2 shows that – under a zero percent interest rate and realistic wage profile – if the worker cannot cash out until retirement, saving does not begin until age 41 (as indicated in Figure 5). However, if there was an opportunity to cash out after 3 years of contributions, saving would begin at age 38. An opportunity to cash out after 2 years induces the worker to start contributing at age 32, and an opportunity to cash out in one year induces saving right away. These results highlight the role that the illiquidity of 401(k)s plays in driving the participation decisions of younger workers.

Table 2: Age at Onset of Saving with Cash Out Option (50 Percent Match, 10 Percent Penalty)

Cash Out Available	Age at Saving Onset
Retirement	41
3 years	38
2 years	32
1 years	25

To further explore the role of liquidity, we repeat our analysis under the assumption that the individual can borrow up to one year of earnings at an interest rate that is two percentage points higher than the rate paid on savings. Borrowing allows for increases in consumption early in life, thereby reducing the match required to induce retirement saving. However, with a zero percent real interest rate on savings and a realistic wage profile, the required match is still over 400 percent at age 25. Saving for retirement begins at age 40 with an employer match and age 51 without. We also repeat our analysis under the assumption that the individual can borrow up to one year of earnings *and* begins working life with debt equal to one year of their age 25 earnings (possibly representing student loans). In this case, the required match to induce participation at age 25 is much higher – 1,649 percent. However, beyond age 25, the results are very similar to those from the case in which borrowing is allowed because in both cases the individual enters future years carrying similar amounts of debt.[2]

[2] These two sets of results – with borrowing, and with initial student debt – are not shown but are available upon request.

IV. Conclusions

We have shown that low retirement saving among young workers – even with standard employer matching – can be rationalized within a life-cycle model under plausible assumptions. That is, we do not need to add behavioral features like present bias to explain this phenomenon. Thus, policies like automatic enrollment – which increase 401(k) participation rates among young workers – may induce choices that deviate from fully rational behavior in a life cycle model. More generally, our model suggests that the age profile of saving can be an important factor to take into account when designing policies that are intended to increase retirement saving.

Our life cycle model is a simple one in which retirement is the only reason for saving. In reality, it may be rational for young people to save for other goals, like buying a house or taking a vacation. We also abstract from uncertainty about future wages, which may induce precautionary saving even at young ages. However, our general argument still applies to retirement saving that occurs in an illiquid employer-sponsored pension account. Our model further abstracts from children. Both men and women with college degrees are typically in their late 20s when they first have children (Livingston 2015a,b). Because children increase consumption needs, saving for retirement before having children may be rational – although our argument would still apply to individuals in their late 20s or 30s who have had children already. Beginning to save at younger ages may help form habits if people are not fully rational. That is, building a habit of saving at younger ages may make saving easier during middle age when it is most important (according to the life cycle model).

The results of this paper have implications for the design of automatic enrollment in defined contribution plans. Encouraging automatic enrollment across the board – for example, through legislation such as the Pension Protection Act of 2006 – is based on the belief that non-participants in employer-sponsored retirement plans are making a mistake. However, our results suggest that nudging people to save for retirement at all points of their career may be inconsistent with a life cycle model. In such a model, it is not optimal for someone whose earnings are temporarily low, such as a college graduate at that start of their career, to save for retirement.

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