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Buffer Stock Saving in Retirement Accounts

Abstract

We use a dynamic programming model to explore the possibility and extent of precautionary saving in tax-sheltered accounts like the 401(k). The main policy experiment examines the behavior of saving for different levels of unemployment insurance (UI), which is a perfect substitute for precautionary saving against job loss. Our results indicate that increasing the generosity of UI crowds out 401(k) contributions made by younger workers, who save primarily for precautionary reasons. At the aggregate level, we find that 401(k)s increase national saving and that the magnitude of the effect depends on the generosity of UI.

David Love[1]
Willams College
Department of Economics

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[1] David Love, Department of Economics, Williams College, Williamstown, MA 01267
E-mail: dlove@williams.edu, Tel: 413-597-3213, Fax: 413-597-4045

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1 Introduction

In 2004 President Bush outlined a proposal to reform Social Security that would allow workers to invest a fraction of payroll taxes in private accounts. If enacted, the proposal will further the trend toward tax-sheltered accounts that began in the late 1970s with the inauguration of the IRA and 401(k) programs. Critics of private accounts point to the poor performance of 401(k)s during the recent decline of the U.S. stock market in 2001 to argue that private accounts are too risky. But if the stock market decline highlighted the riskiness of 401(k)s, the recession that followed illustrated a potential advantage: flexibility. Unlike traditional pensions or Social Security, the 401(k) rules allow participants to make pre-retirement withdrawals when they leave their jobs. The withdrawals are penalized at 10 percent, but they can still provide a buffer against income loss during unemployment. While the riskiness of 401(k)s has received a lot of attention from the media, the potential for 401(k)s to provide self-insurance against income fluctuations has been largely ignored. We examine the conditions under which a 401(k) plan can serve as a precautionary saving vehicle and explore the implications this has for national saving.

The economy in the paper extends the life-cycle frameworks of Engen, Gale, and Scholz (1994) and Laibson, Repetto, and Tobacman (1998) by modeling job loss and unemployment insurance (UI). The inclusion of UI allows us to measure the extent of precautionary saving in the 401(k) by observing how contributions and saving respond to changes in the UI replacement rate. Since UI is a perfect substitute for buffer saving against unemployment shocks, its effect on saving both inside and outside the 401(k) provides information about the motive for saving. In particular, if an account is used as a precautionary vehicle against employment risk, higher rates of UI should reduce saving in that account during periods when the precautionary motive is dominant. Results from the model simulations show that increasing the generosity of UI crowds out 401(k) contributions made by younger workers, who save primarily for precautionary reasons. Using the benchmark parameters, we find that raising the UI rate from 10 percent to 70 percent reduces the ratio of contributions to income by an average of 86 percent for the first 10 years of working-life. In contrast, saving in the unsheltered account falls only slightly in response to higher rates of UI.

The possibility of early withdrawals from the 401(k) has fueled concern about leakage from retirement saving. Munnell and Sundén (2004) report that individuals who took a lump-sum distribution from a 401(k) plan cashed out a median amount of $6,000 (in 2001 dollars). Poterba, Venti, and Wise (2001) estimate the loss in retirement savings associated with these cashouts and find it to be about 5 percent. These studies measure the losses due to early withdrawals, but they do not account for the increase in contributions attributable to the possibility of self-insurance in the 401(k). Instead of interpreting early withdrawals as a consequence of bad decision making, we find that a rational saver will not only withdraw from the 401(k) during unemployment, she will actually *plan* to do so.

The introduction of 401(k) plans affects national saving in the model economy through two channels. First, the flexibility of the plans allows agents to use the 401(k) to self-insure against unemployment shocks, and consequently, there is a substitution of saving from the unsheltered account to the 401(k). Second, the substitution is complemented by higher saving because the 401(k) is a more attractive vehicle for life-cycle saving. Simulations suggest that 401(k)s have a positive effect on overall saving. Relative to a model economy without 401(k)s plans, we find that introducing 401(k)s increases the steady-state national saving rate by between 1 and 3 percentage points, depending on the assumptions about UI. Consistent with previous simulations of the UI system (e.g., Engen and Gruber, 2001), we find that increasing the generosity of UI decreases national saving for both economies, but that the effect is largest in the economy without 401(k)s. Whether 401(k)s actually increase overall saving remains a subject of some controversy in the empirical literature.[1]

The remainder of the paper proceeds as follows. Section 2 discusses institutional features of

[1] Eric Engen, William Gale, and Karl Scholz find that retirement accounts have little effect on national saving (q.v., Engen, Gale, and Scholz, 1994, 1996; and Gale and Scholz, 1994), while James Poterba, Steven Venti, and David Wise argue the opposite (q.v., Poterba, Venti, and Wise, 1995, 1997; and Venti and Wise, 1986, 1990, 1995).

the 401(k) that are relevant for the model. Section 3 presents the model. Section 4 discusses the data, the choice of parameters, and the solution technique. Section 5 calculates the extent of self-insurance in the 401(k) and the net effect on national saving. Section 6 concludes.

2 401(k) Rules and Precautionary Saving

This section discusses three features of the 401(k) that limit the degree of substitution between 401(k)s and unsheltered accounts: withdrawal penalties, contribution limits and employer matching. Each of these features introduces nonlinearities into the budget constraint that play an important role in determining optimal saving in the model.

Withdrawal penalties The withdrawal rules on the 401(k) are designed to promote retirement savings. Except under special circumstances, withdrawals made before the age of 59.5 are penalized or prohibited entirely.[2] After this age, withdrawals are unpenalized but taxed at the relevant marginal income tax rate.[3] With the exception of plan loans, the most common means of accessing 401(k) balances before retirement is to take a lump-sum distribution in the event of a job separation. Lump-sum distributions account for the majority of leakage from 401(k) plans, and plan loans have only a small effect in comparison (Munnell and Sundén, 2004). Each 401(k) plan is specific to the firm, and when a separation occurs through either quitting or firing, the individual must choose one of three options. The individual can leave the 401(k) balance in the existing plan, the plan can be "rolled over" unpenalized into either a new 401(k) or an IRA, or distributions may be taken with a cost. If the individual chooses to take a distribution on some portion of the 401(k) plan, the amount is both penalized at 10 percent and taxed as ordinary income.

[2] An individual can withdraw pre-retirement if she meets one of the following conditions for hardship: she is totally disabled; she dies, and the money goes to a beneficiary; medical expenses accumulate to more than 7.5% of gross income; money is owed to a divorced spouse; or the money is needed for home equity.

[3] This consumption tax treatment in conjunction with a progressive income tax schedule may provide individuals with an incentive to smooth distributions taken in retirement. The only legal restriction imposed after retirement is that minimum distributions must be taken after age 70.5.

Contribution limits Two limits, both set by the passage of the Employee Retirement Income Security Act (ERISA), are relevant to a model of 401(k) plans. First, there is a general limit on total defined contributions equal to either $40,000 or 100 percent of earned income, whichever is less. This limit applies not only to contributions into the 401(k), but also those into other defined contribution (DC) plans such as an IRA, Keogh, or TIAA-CREF. Second, in addition to the total DC limit, there is also an elective contribution limit of $12,000 placed on pre-tax contributions to a 401(k). The purpose of the limit from the government's perspective seems to be to promote savings in the middle classes, while restricting the tax breaks for higher income groups (Gokhale, Kotlikoff, and Warshawsky, 2001). Since asset shuffling is presumed to be most prevalent among the wealthy, who are more likely to be extra-marginal with respect to the limit, the government can reduce its revenue loss by imposing a limit on those least likely to fund saving out of depressed consumption.

Matching Employer matching, if offered, provides workers with a strong incentive to contribute to 401(k)s. Using a recent survey of participants, the Investment Company Institute (2000) reports that the employer match is the second most prevalent reason for participating in a 401(k), behind only "concern about funding retirement." Each matched dollar placed in the account, once vested, represents a large and secure return for the employee. The particular matching formula offered by a given firm varies largely because of differences in employee demand, turnover rate, and equity of participation.[4] Firms offering employer matching typically limit the fraction of income they are willing to match,[5] but matched contributions within that range can be substantial.[6]

[4] Nondiscrimination tests restrict the degree to which highly compensated employee contributions can exceed those of other workers in the firm. This acts as an incentive for management to increase participation among less well remunerated employees.

[5] Olivia Mitchell (1999) reports that the modal match limit was 6 percent of income in 1997. Over 86 percent of plans had match limits below 6 percent.

[6] Basset, Fleming, and Rodrigues (1998) use the 1993 Current Population Survey and find a mean match rate of 62.3 percent for plans offering a positive match rate.

3 The model

The model economy is populated by three types of agents: high school dropouts, high school graduates, and college graduates. Life-spans are uncertain but last no longer than T periods. Let ϕ_t denote the unconditional survival probability of living to age t. The conditional survival probability is then given by $p_t = \phi_t/\phi_{t-1}$. Each agent shares the same preferences, given by

$$E_t \sum_{i=t}^{T} \phi_i \beta^{i-t} u(c_i), \tag{1}$$

where β is the discount factor, c_t is real consumption, and E_t is the expectations operator. The period utility function is $u(c_i) = c_i^{1-\sigma}/(1-\sigma)$, where σ is the coefficient of relative risk aversion.

Agents begin working at age 20 and retire at age 65. During the working years, agents receive an income of y_t each period. (The income process differs by education type, but we omit subscripts for notational convenience.) Log income follows an AR(1) process that includes the possibility of unemployment:

$$\ln(y_t) = emp_t\,(g(\mathbf{z}_t) + \eta_t) + (1 - emp_t)\ln(UI_t), \tag{2}$$

where emp_t is an indicator variable that equals 1 if the agent is employed and 0 otherwise, $\mathbf{z}_t$ is a vector of characteristics, $g(.)$ is a trend component that depends on the characteristics, η_t is an autoregressive shock, and UI_t is unemployment insurance modeled as a fraction θ of last period's income. Retirement income, not including interest payments, consists primarily of government transfers and is captured by a linear trend that depends on $\mathbf{z}_t$. The probability of being unemployed in a given period is a function of age and education but does not depend on previous unemployment.

Agents hold the same portfolio of risky assets in two possible locations: a 401(k) plan and an unsheltered account. The gross return R_t on the assets is uncertain and distributed lognormally. Borrowing from either account is prohibited. The evolution of saving in the unsheltered account is given by[7]

$$s_{t+1} = R_t s_t + y_t - c_t - x_t - taxes_t - pen_t, \tag{3}$$

where s_t denotes unsheltered savings held at the beginning of the period, x_t is the contribution to (if positive) or withdrawal from (if negative) the 401(k) plan, and pen_t denotes any early withdrawal penalties that must be paid. Total taxes are represented by the second-to-last term and include income taxes, return taxes, a flat UI tax, and the tax deduction (liability) of the 401(k) contribution (withdrawal). The income tax schedule is a simplified version of the 2000 tax code.[8] The marginal tax rate is 15 percent on income below $26,250, 28 percent on income between $26,251 and $63,550, 31 percent on income between $63,551 and $132,600, 36 percent on income between $132,601 and $288,350, and 39.6 percent on income above $288,350. Capital gains are taxed at 10 percent if income is under the 15-percent bracket, and 28 percent in all other brackets.[9] In addition, the individuals are allowed a standard deduction of $4,400. Taxable income is then current income minus both the deduction and 401(k) contributions (or withdrawals).

The early withdrawal penalty function is given by

$$pen_t = \begin{cases} -\kappa \min(0, x_t) & \text{if } t < 65 \\ 0 & \text{if } t \geq 65, \end{cases} \tag{4}$$

where κ is the penalty rate on early withdrawals made during unemployment. With the exception of plan loans, the 401(k) rules only permit withdrawals in the event of a job separation or under hardship provisions. We therefore constrain contributions during employment to be non-negative. Only part of the cost of early withdrawals is captured by pen_t. The withdrawal penalty applies to the pre-tax amount of withdrawals, so the full cost of early withdrawals includes both the penalty and income taxes that must be paid on the amount withdrawn.

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7 The formulation of the asset accumulation constraints is similar to that used in Laibson, Repetto, and Tobacman (1998). The primary departures in my model are a stochastic return, an explicit treatment of unemployment, and the inclusion of unemployment insurance.

8 The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) significantly changed the relevant tax rates and brackets. Since the PSID data used in the paper cover periods before the EGTRRA, I do not model the new tax system.

9 All returns in the model are taxed as capital gains. Thus, the tax advantage of 401(k)s in the model is essentially a lower bound.

The evolution of assets in the 401(k) plan is given by

$$a_{t+1} = R_t a_t + x_t + m_t, \tag{5}$$

where a_t denotes savings held in the 401(k) plan at the beginning of the period, and m_t is the amount of employer matching. The employer-matched contributions are determined by a matching formula that comprises a match rate and a firm-specific match limit. Let μ be the percentage of employee contributions the firm is willing to match, and ψ be the maximum fraction of income for which the firm is willing to match contributions. Matched contributions are then given by

$$m_t = \max[0, \mu \min(x_t, \psi y_t)]. \tag{6}$$

Equation (6) reflects the property that matches are zero if contributions are negative. The agent must be employed in order to contribute, and contributions cannot exceed the elective limit L.

The agent's problem is as follows. At the beginning of period t, the agent observes realizations of current income, returns, and the employment state. The agent then chooses consumption and saving in both accounts in order to maximize utility, given by equation (1), subject to constraints. The value function for this problem is given by

$$V_t(s_t, a_t, \eta_t, emp_t) = \max_{c_t, x_t} \left\{ u(c_t) + \beta p_t E_t \left[V_{t+1}(s_{t+1}, a_{t+1}, \eta_{t+1}, emp_{t+1}) \right] \right\}, \tag{7}$$

subject to the following constraints.

$$s_{t+1} = R_t s_t + y_t - c_t - x_t - taxes_t - pen_t$$

$$a_{t+1} = R_t a_t + x_t + m_t$$

$$s_t \geq 0, \; a_t \geq 0$$

$$x_t \leq L \;\text{ if } t < 65$$

$$x_t \geq 0 \;\text{ if } emp = 1$$

$$x_t \leq 0 \;\text{ if } t \geq 65.$$

The set of state variables for the problem is $\{s_t, a_t, \eta_t, emp_t\}_{t=0}^{T}$. Trend income is deterministic and can therefore be absorbed into the time state. The set of choice variables for the problem is $\{c_t, x_t\}_{t=0}^{T}$. Saving in the unsheltered plan is jointly determined by the choices of consumption and contributions to the 401(k) plan. The agent forms an expectation in period t of next period's income using knowledge of both trend income $g(\mathbf{z}_{t+1})$ and the current period's AR(1) component of income, $\eta_t = \ln(y_t) - g(\mathbf{z}_t)$.

The expectation in equation (7) is taken over income-, return-, and employment uncertainty. Specifically,

$$E_t\left[V_{t+1}(.)\right] = \sum_{i=0,1} \Pr(emp_{t+1} = i) \int \int V_{t+1}(s_{t+1}, a_{t+1}, \eta_{t+1}, i) dF(\eta_{t+1}|\eta_t, t) dG(R_{t+1}), \quad (8)$$

where $F(\eta_{t+1}|\eta_t, t)$ and $G(R_{t+1})$ are the income and return distributions. In practice, we integrate the expectation in equation (8) using two-dimensional Gauss-Hermite quadrature of order 6 on income and order 4 on the return. Beginning with the last period T, equation (7) can be solved recursively to yield consumption and saving functions, which take income and asset levels in each account as their arguments.

4 Data and calibration

4.1 Income profiles

We estimate income profiles and error structures using data from the Michigan Panel Study of Income Dynamics (PSID) over the interview years 1988 to 1997. Head-of-household earnings is the dependent variable and consists of pre-tax labor income, social security distributions, and transfer income. It excludes UI because the income process in equation (2) separates UI from trend income. Except for the exclusion of UI, the definition of income follows Laibson, Repetto, and Tobacman (1998), and Engen, Gale, and Scholz (1994).

We divide the sample by education group (dropouts, high school graduates, and college graduates) and estimate two earning equations for each group: one for working years and the other for retirement. In order to avoid double counting spells of unemployment, we exclude observations for which the head of the household did not report a working status of "employed." A household is considered retired if no member works more than 1,500 hours in a sample year, and the household head is older than 55. Finally, we remove observations at the extreme ends of the income distribution, which contain households earning less than \$500 or more than \$1,500,000 in year-2000 dollars.

The estimation model assumes log earnings is a linear function of household size (FAM), an age polynomial of degree 3 for workers and degree 1 for retired households (**AGE**), birth year dummies (**BYEAR**), and the state unemployment rate as a proxy for time-specific business cycle effects (UE).

$$\ln y_{it} = \beta_1 + \beta_2 FAM_{it} + \mathbf{AGE}_{it}\boldsymbol{\beta}_3 + \beta_4 UE_{it} + \mathbf{BYEAR}\boldsymbol{\beta}_5 + \eta_{it} + \nu_i \tag{9}$$

$$\eta_{it} = \rho\eta_{it-1} + \varepsilon_{it},$$

where

$$\nu_i \sim N(\mathbf{0}, \sigma_\nu^2 \mathbf{I}_T)$$

$$\varepsilon_i \sim N(\mathbf{0}, \sigma_\varepsilon^2 \mathbf{I}_T),$$

and $\boldsymbol{\nu}$ and $\boldsymbol{\varepsilon}$ are orthogonal to each other and the other independent variables.

We estimate equation (9) using an error component model developed by Lillard and Willis (1978). We first run a GLS regression on the pooled data. Then we run a random effects regression on the residuals, allowing for the possibility of autocorrelation in the error. Each residual can then be decomposed into its transitory and serially correlated components. Using the definitions of errors in equation (9), the residuals can be written as

$$\ln y_{it} = \eta_{it} + \nu_i \tag{10}$$

$$\eta_{it} = \rho\eta_{it-1} + \varepsilon_{it}. \tag{11}$$

The random effects regression produces estimates of ρ, σ_ν^2, and σ_η^2, but the simulation model requires an estimate of σ_ε^2. It is possible to combine (10) and (11) to find the following expression for the total variance:

$$\sigma_y^2 = \sigma_\nu^2 + \sum_{j=0}^{\infty} \rho^{2j} \sigma_\varepsilon^2 = \sigma_\nu^2 + \frac{\sigma_\varepsilon^2}{1-\rho^2}. \tag{12}$$

Combining this result with the identity $\sigma_y^2 = \sigma_\nu^2 + \sigma_\eta^2$, the variance of the shock on the autoregressive component of income can be written $\sigma_\varepsilon^2 = \sigma_\eta^2(1-\rho^2)$.

Table 1 displays the coefficient estimates and standard errors for the regression on equation (9). The results are generally consistent with earnings regressions estimated in other papers.[10] The sign pattern of the age polynomial coefficients (+ - +) reflects the well-known hump shape of earnings over the life cycle. The correlation parameter estimates on the AR(1) process are similar across the education groups and show a moderate degree of persistence. Roughly 70 percent of a shock to labor income remains in the next period. Estimates of the transitory variances are somewhat larger than previous estimates, with standard deviations ranging from 0.33 for high school graduates to 0.36 for college graduates. Since the estimate of transitory variance picks up measurement error in addition to idiosyncratic shocks, it is unlikely that these values accurately reflect transitory uncertainty. The income process in the paper models only persistent AR(1) shocks to income, so we do not use the transitory estimates in the solution of the model. Estimates of the persistent variances imply standard deviations of 0.210, 0.167, and 0.161 for dropouts, high school graduates, and college graduates.

Figure 1 displays the estimated earnings profiles for each education group. Earnings for all groups follow a hump-shaped pattern that peaks around age 50. High school dropouts have a much flatter profile than either high school graduates or college graduates but have a higher replacement rate in retirement. Non-asset income of college graduates drops far more precipitously at retirement compared to the other two groups. The shape of the income profile plays a key role in determining life-cycle saving. The large hump for college and high school graduates suggests a saving pattern of low saving for the young, substantial accumulation for the middle aged, and large

[10] For previous estimates, see Abowd and Card (1989), Carroll (1992), Engen, Gale, and Scholz (1994), Hubbard, Skinner, and Zeldes (1995), and Laibson, Repetto, and Tobacman (1998).

dissaving in retirement. In contrast, the relatively flat profile of high school dropouts suggests a more limited role for life-cycle saving.

4.2 Unemployment

Unemployment in the model is involuntary and occurs with a probability that depends on age and education. A close empirical analogue to this process is job displacement, which is defined as a job separation caused by a plant closing, a layoff, or an employer going out of business. We construct unemployment probabilities using displacement rates from a paper by Henry Farber (1997). Farber analyses data from the Displaced Workers Survey (DSW) supplement to the Current Population Survey (CPS) and reports displacement rates for three-year intervals over the period 1981 to 1995.

Farber categorizes displacement rates by education and age. For each age category, we calculate the average three-year rate of job loss for all occupations using Farber's Table A-3. We then perform the same exercise for each education category listed in Farber's Table A-4. Next, we combine these two measures by multiplying the displacement rates for each age category by 1 plus the percentage gap between the education-specific rate and the average rate for all educational groups. The corresponding weights are 1.31 for dropouts, 0.98 for high school graduates, and 0.70 for college graduates. These probability measures apply to the event of losing a job in a three year period. We transform them into one-year probabilities by assuming that the rate of displacement is constant for each period. This assumption, if anything, understates the annual rate of displacement since the DWS does not control for multiple job losses in the three year span. For each age category $i \in \{$20-24, 25-34, 35-44, 45-54, 55-64$\}$, and each education group $j \in \{$dropout, high school graduate, college graduate$\}$, we define the unconditional probability of job loss as

$$\Pr(emp_{ij} = 0) = 1 - (1 - r_{ij})^{1/3},$$

where r_{ij} is the average three-year education-weighted displacement rate between 1989 and 1995.

Table 2 reports the displacement probabilities. The likelihood of experiencing unemployment decreases substantially with age and education. High school dropouts are nearly twice as likely to lose their jobs as college graduates, and the young are about 50 percent more likely to lose their jobs than the old. An implication of this is that the precautionary saving motive should play a larger role for the young and less-highly educated.

4.3 Parameters and solution

The life-cycle parameters are reasonably standard. Agents start life at age 20, retire at 65, and live to a maximum of 85 years. For all ages under 85, we calculate the conditional survival probabilities from the National Center for Health Statistics U.S. Life Tables, 1999. We set the discount factor β equal to 0.967, which, together with the survival probabilities, tends to offset the effect of the return on intertemporal consumption. For the baseline specification, we set the coefficient of relative risk aversion σ to 3, which is within the range of commonly used values. Because the coefficient of relative risk aversion plays such a fundamental role in precautionary saving, we solve the model for values of σ ranging from 1 to 5.

The parameters for the 401(k) plan match those of a typical 401(k) plan. The contribution limit L equals $10,500, which was the elective contribution limit in 2000. For the baseline specification of the employer match, we set $\mu = 0.50$, and $\psi = 0.06$. This is the modal match in the data, offered by 26 percent of plans with matching in 1997. In order to test the sensitivity of results to the match rate, we also solve the model for values of μ ranging from 0 to 100 percent. The penalty rate on early withdrawals κ is 10 percent, which is the penalty rate set by ERISA on pre-retirement withdrawals. Consistent with the rules governing 401(k)s, withdrawals are prohibited during employment.[11]

The structure of UI in the model broadly matches the UI system in the U.S. Agents receive a fraction θ of previous income during unemployment, and benefits last the duration of unemployment. As in the U.S., UI benefits are treated as taxable income. Because of the added

[11] Plan loans, when offered, are an exception. we do not model plan loans, but including them would make the results regarding the potential for self-insurance in 401(k) plans even stronger.

computational complexity, we do not model several important features of UI, including duration limits, experience rating, and qualification. To the extent that these features alter the generosity of UI, they are partly captured by different values of θ. Including UI in the model allows us to test the degree to which the 401(k) plan is used as self-insurance against drops in income that occur during unemployment. We measure this by observing how saving decisions change when θ varies over a range of values between 10 and 70 percent.

The portfolio allocation approximates the average 401(k) portfolio allocation reported in Holden and VanDerhei (1999).[12] Agents maintain a portfolio composed of 60 percent stocks and 40 percent T-bills. We assume that stocks have a mean return of 8 percent and a standard deviation of 20 percent, and T-bills have a mean return of 0.6 percent and a standard deviation of 4.5 percent. Together with the portfolio weights, these imply that the portfolio has a mean return of 5 percent and a standard deviation of 15 percent. We make the added assumption that the agent holds the same portfolio in both accounts, but this is probably inaccurate since tax sheltering provides an incentive to place more heavily taxed assets (e.g., stocks) in the 401(k) plan. Ideally, agents in the model would be able to choose separate allocations in both the 401(k) and the unsheltered account, but this would add two more choice variables and would be computationally infeasible.

Once the model is parameterized, we solve the dynamic programing problem using discrete space methods.[13] Working backwards from age 85, the program calculates $V_t(s_t, a_t, \eta_t, emp_t)$ for each member of the discretized state space and interpolates in order to define the value function over the continuous state space. The solution to the model yields a set of value functions and decision rules for ages 20 to 85. We run 20,000 simulations for each education group and average the results over life-cycle experiences. Agents enter the first period with no assets, and there are

[12] They find that in 1999, equity funds composed 53 percent of the allocation, while company stock composed 19 percent. The remainder was split between bonds and other low risk assets.

[13] The solution method is outlined in Love (2003). Computer code (C++ and Gauss) for the solution and simulation is available upon request.

no bequests.

As a basis of comparison, we perform the same simulation exercise on a similar economy without 401(k) plans. Since employer matching is a form of compensation, we increase labor income in the non-401(k) economy in order to make the two economies comparable. For each education group, let M be the simulated total matches in the 401(k) economy, and Y be the simulated total labor income in the non-401(k) economy. For each age before retirement, trend income in the non-401(k) economy is increased by $100M/Y$ percent. To a close approximation, this raises income in the non-401(k) economy by an amount equal to the value of matching in the 401(k) economy.

In order to compute national saving, we aggregate the economies in an OLG framework. The aggregated life-cycle profiles differ from the individual profiles through the population distribution and cohort-specific economic growth. Births grow at rate n, and the real variables of each cohort, including the tax schedule, are $(1+g)$ times the size of those of the preceding cohort. We assume that the government maintains a balanced budget in all periods so that national saving equals private saving.

5 Results

The results from the simulations address two sets of issues. The first is the role of self-insurance in the 401(k) plan, and the second pertains to the net impact on national saving. The section begins with a discussion of benchmark simulations which show substantial withdrawals from the 401(k) plan during unemployment. We then test for precautionary saving in the 401(k) plan by experimenting with changes in UI and find that agents in the model use the 401(k) plan as a self-insurance vehicle against income loss during unemployment. The section concludes by looking at the aggregate results on national saving.

5.1 Benchmark simulations

Figure 2 depicts a single simulation of the working life of a high school graduate using the benchmark parameters ($\sigma = 3, \theta = 0.10$, $\mu = 0.50$, and $\psi = 0.06$). Although the figure presents only one simulation out of 20,000, it shows several key features of the model. The first thing to notice is that saving in both accounts fluctuates over the working life to smooth consumption. While contributions tend to fall during periods in which income is low relative to its expected value, the majority of adjustment occurs along the margin of saving in the outside account. An exception to this is unemployment. Figure 2 demonstrates how 401(k) withdrawals are used to absorb shocks to income caused by unemployment. During periods of unemployment (ages 37, 43, 49, and 62), consumption is supported primarily through substantial withdrawals from the 401(k). This suggests that 401(k) savings can potentially act as a buffer against employment risk, but it is unclear whether agents deliberately self-insure in the plan. Bad luck, for instance, might lead the individual to dip into her retirement account even though she never anticipated having to do so. Self-insurance requires not only that the agent access the 401(k) during unemployment, but that she plans for it by building up savings in the 401(k) plan.

Another feature that is shown in this single simulation is the importance of the contribution limit to saving in the 401(k). For about 16 years, contributions are very close to the elective contribution limit. The implications of a binding contribution limit are twofold. First, when contributions run up against the limit, desired saving in the 401(k) is likely to exceed actual saving, with the residual getting absorbed by some combination of increased saving and consumption. Whether the residual actually ends up in other saving depends on the wedge induced by the contribution limit on the marginal incentive to save. At the contribution limit, the expected return on saving another dollar falls due to the lost tax advantage.[14] The second effect of the contribution limit is more subtle. Because individuals will anticipate the likelihood of a binding

[14] With a matching limit of 6 percent, contributions near the limit are unlikely to be matched. Thus, the wedge is smaller than it would be if the contribution limit were lower.

constraint, they may smooth their contributions over time. This is an important point. Just because a contribution limit does not bind ex post does not imply that the contribution limit had no effect on saving.[15] As will be seen in the results below, the importance of the contribution limit depends both on the firm match rate as well as the generosity of UI.

Single simulations are useful for showing how agents in the model respond to economic shocks, but the main results of the model come from averaging the simulations. Figure 3 shows the average profiles corresponding to the single simulation in Figure 2. When the model is simulated many times, some of the effects that are visible after one simulation wash out in the average. For example, even though the contribution limit was frequently binding in the single simulation, contributions cannot reach the elective limit on average. This is due to the fact that positive income shocks cannot push contributions above the limit, while negative shocks can push them below. In line with predictions from the buffer-stock saving literature, consumption closely tracks income for about 15 years before leveling off through retirement. (Strictly speaking, in a life-cycle model with income uncertainty and preferences that generate precautionary behavior, it is not possible to cleanly separate precautionary saving from life-cycle saving. Nevertheless, these motives will change in importance over the life cycle, with the precautionary motive dominating in earlier years and the life-cycle motive dominating in later years.) During this same period, saving in both accounts is low but positive, suggesting the presence of precautionary saving. As the life-cycle saving motive becomes more important, contributions rise relative to other saving, while other saving actually becomes negative on the other side of the income hump. It is evident from the picture that withdrawals from conventional saving are used to prop up contributions and consumption during the predictable decline in income just before retirement.

[15] Carroll and Kimball (2001) provide theoretical foundations for the interaction between liquidity constraints and precautionary savings.

5.2 Self-insurance in the 401(k)

We now consider how changes in the generosity of UI affect saving behavior and present results for $\theta = 0.10,\ 0.30,\ 0.50,$ and 0.70. Table 3 displays the average withdrawal taken from the 401(k) during spells of unemployment by each education group for different values of the match rate (μ). The withdrawals are substantial. High school graduates, for example, withdraw on average \$1,138 to \$15,862, depending on the values of μ and θ. As would be expected, withdrawals decline with θ and rise with μ. At lower match rates, asset accumulation inside the 401(k) is lower, so less is available in the event of job loss. A more surprising trend in the table is the relative size of withdrawals across education groups. High school dropouts, who have the lowest expected income, tend to withdraw larger amounts from their plan than high school and college graduates. The reason for this has to do with the fact that high school and college graduates have hump-shaped profiles which provide an incentive to save in the unsheltered account in order to smooth consumption over the declining portion of the pre-retirement hump. A by-product of this incentive is the creation of a large stock of outside savings that can be tapped during unemployment. In contrast, the relatively flat income profiles of dropouts lead them to accumulate less unsheltered savings, and as a consequence, they rely more heavily on 401(k) withdrawals during unemployment. Dropouts also withdraw more during unemployment because they face lower marginal tax rates, and therefore withdrawal costs, than high school and college graduates.

While 401(k) plans are evidently drawn upon during unemployment, it is unclear how much saving in the 401(k) is done in anticipation of that event. The responses of unsheltered saving and 401(k) contributions to changes in UI can be used to assess the degree to which the 401(k) substitutes for precautionary savings against employment fluctuations. If individuals save in the 401(k) strictly for retirement, while buffering against wage and employment uncertainty in the conventional account, then an increase in UI would likely induce individuals to save less in the conventional account. This reduction in saving would free up resources available for higher consumption and 401(k) contributions. If, on the other hand, 401(k) plans substitute for a buffer against employment risk, then the opposite should occur; higher UI rates should correspond with lower 401(k) contributions and potentially higher conventional saving.

Table 4 reports average ratios of conventional saving and 401(k) contributions to income for different UI replacement rates. Looking at the behavior of saving and contributions for different values of θ, the 401(k) plan appears to be the primary vehicle for self-insurance against income loss during unemployment. The first row for each education group displays contribution- and saving ratios for individuals in the first 10 years of life when saving is most likely to be precautionary. Contributions drop significantly when θ rises from 10 to 70 percent. Contribution ratios decline by 67 percent for dropouts, 88 percent for high school graduates, and 99 percent for college graduates. Saving in the conventional account falls as well, but not nearly as much; the respective decreases are 14 percent, 39 percent, and 31 percent for the three education groups. This pattern largely disappears for the two age groups in the middle (ages 30 to 50) and reverses itself for the middle-aged (50-64), who actually save more in both accounts with higher replacement rates of UI.

Referring back to the single simulation in Figure 2, it is clear that saving in *both* accounts falls during an unemployment spell. This phenomenon makes it difficult to identify precisely how much the 401(k) substitutes for precautionary saving. Nevertheless, it is clear that agents do self-insure in the 401(k) plan. Otherwise, an increase in the generosity of UI would have the effect of decreasing unsheltered saving and increasing (or leaving unchanged) 401(k) contributions. In the model, we see the opposite effect: 401(k) contributions fall by a much larger percent than unsheltered saving in response to an increase in θ.

An important aspect of 401(k)s from a policy perspective is the effect of the contribution limit on saving behavior. In general, the number of years the contribution limit binds depends positively on education and UI generosity and negatively on the match rate. For $\mu = 0.50$ and $\theta = 0.10$, the average number of years spent contributing at the limit is 2.8 for dropouts, 13.5 for high school graduates, and 15 for college graduates. Increasing μ from 0 to 50 percent reduces the average number of years a high school or college graduate contributes at the limit by about 20 percent for all values of θ. The reason for this involves the evolution of the saving motive over the life cycle. At lower values of μ, there is less incentive to contribute to the 401(k) early in life when the precautionary motive predominates. As retirement saving becomes more important, however, the agent compensates for the lower initial accumulation in the 401(k) plan by increasing contributions and therefore the likelihood that the limit binds.

The firm matching limit also has a significant impact on 401(k) contributions. Consistent with the empirical findings in Kusko, Poterba, and Wilcox (1998), the simulations show a considerable amount of clustering around the matching limit. The number of years agents contribute near the matching limit (between 95% and 105% of ψy_t) depends positively on μ and negatively on θ and education. For $\mu = 0.50$ and $\theta = 0.10$, the average years spent contributing near the matching limit is 18.5 for dropouts, 12.3 for high school graduates, and 11.7 for college graduates. Increasing μ from 25 percent to 50 percent increases the time spent near the matching limit by between 50 and 90 percent for all specifications of the model. Increasing θ has the opposite effect. Increasing θ from 10 percent to 70 percent reduces the time spent near the matching limit by between 13 and 54 percent. The influences of matching and UI are closely related. Agents save in the first 10 years of life primarily to buffer against income fluctuations that are caused in part by unemployment. Higher values of μ make the 401(k) a more desirable precautionary vehicle against employment risk, but higher values of θ reduce the cost of unemployment and therefore reduce the desire to self-insure against unemployment shocks in the 401(k).

5.3 National saving

We now turn to the aggregate level and discuss the implications of the model for national saving in the steady state. For different specifications of the model, we compare aggregate results for an economy with 401(k)s to one that does not have 401(k)s but is similar in all other respects. Table 5 displays national saving rates for both economies by unemployment generosity for different values of the birth rate n and cohort-specific economic growth rate g.

For all values of θ, saving is higher in the economy with 401(k) plans. Depending on the values of n and g, saving rates in the 401(k) economy are between 1 and 3 percentage points higher than saving rates in the economy without 401(k)s. These correspond to increases in aggregate saving of between 17 and 40 percent. The magnitude of the impact of 401(k)s on saving is consistent with results in Laibson, Repetto, and Tobacman (1998).[16] The effect of 401(k)s on saving operates through two different channels. First, the flexibility of the plans allows for a considerable degree of self-insurance against the effects unemployment. This induces agents to substitute saving from the unsheltered account into the 401(k). Second, 401(k) plans offer a higher marginal incentive to save, so this substitution is complemented by higher saving in the 401(k) for life-cycle reasons.

For both economies, increasing θ decreases aggregate saving, but the effect is more pronounced in the economy without 401(k)s. For a combined growth rate $(n + g)$ of 6 percent, increasing θ from 10 to 70 percent leads to a 35.4 percent reduction in the national saving rate for the 401(k) economy and a 45.6 percent reduction for the non-401(k) economy. The explanation for this difference has to do with the saving incentives in the early part of the life cycle. Younger workers in the economy without 401(k)s save primarily to buffer against income fluctuations. At higher values of θ, UI crowds out precautionary saving against job loss nearly one-for-one. In the economy with 401(k)s, younger workers contribute to the 401(k) both because it is flexible enough to serve as a precautionary vehicle, but also because the incentives of tax sheltering and employer matching in the 401(k) make life-cycle saving attractive at an earlier age. UI substitutes for the part of contributions that is attributable to the precautionary motive, but it does not affect life-cycle saving.

[16] For a CRRA parameter of 3, they find an increase in aggregate saving of between 23.2 and 25.5 percent in an economy without hyperbolic discounting.

6 Conclusion

Our simulation exercises suggest that saving is done in the 401(k) for two reasons: to accumulate resources for retirement and to build a buffer stock against potential income loss due to unemployment. While the first reason is obvious, the second is novel and has implications for the effect of employment risk on saving.

Two results in the paper support the idea that some precautionary saving is done inside the 401(k) plan. First, savings in the plan are regularly tapped in the event of unemployment, and the size of the withdrawals is large. In an economy with a 50 percent match and a 50 percent replacement rate of UI, the average withdrawal from the 401(k) during unemployment is approximately $8,000. Second, increasing the generosity of UI, which is a perfect substitute for precautionary saving against employment risk, is associated with a large reduction in 401(k) saving for the young. Saving in the unsheltered account falls as well, but by much less than in the 401(k).

In contrast to the popular perception that early withdrawals from the 401(k) represent poor planning on the part of the individual, our interpretation is exactly the opposite. A fully rational saver will not only withdraw from her 401(k) plan during unemployment, but more significantly, she will actually plan to do so. This does not mean that for a given level of savings in both accounts the individual would prefer to withdraw from the 401(k). Rather, the opportunity cost of saving in the outside plan, in terms of forgone matching and tax benefits, is too high.

The possibility of self-insurance in the 401(k) also appears to have important effects at the aggregate level. When we compare a model economy with a 401(k) plan to one without, we find that introducing the 401(k) increases the national saving rate by between 1 and 3 percentage points in the steady state. The magnitude of the impact on saving depends on the generosity of UI and the extent of employer matching. Saving in both economies falls with higher replacement rates of UI, but the reduction is greatest in the economy without a 401(k) plan.

The analysis in the paper could be extended and improved in several ways. First, the analysis should ideally be carried out in general equilibrium. The assumption of partial equilibrium is inaccurate to the extent that responses of saving to changes in UI and 401(k) incentives feed back into the capital stock, returns, and wages.[17] The partial equilibrium assumption is not critical to the paper's main conclusion about the possibility of self-insurance in the 401(k) plan, but it does make a difference for the results pertaining to aggregate saving. Second, the simulation results pertaining to self-insurance in the 401(k) need to be tested empirically. One approach to this would be to measure the degree of precautionary saving in the 401(k) using state variation in unemployment insurance using data from the Survey of Income Program Participation. Empirical analysis is especially important in light of recent research suggesting that 401(k) participants behave in ways quite different from the optimizing agent in the model.[18] If the empirical results corroborate the simulation findings, the model could have important policy implications for the current debate about privatizing Social Security in the U.S.

Although this debate has been framed broadly in terms of risk and return, one could argue that this is really part of a more general tension between paternalism and flexibility. The current system is paternalistic, in that it provides a reasonably secure flow of retirement income, but it is also completely illiquid for people in their working years. Our results suggest that there might be gains associated with making the retirement saving system more flexible. Of course, if saving behavior is not rational, greater flexibility could create leakages from retirement savings that are inefficient in their own right. Understanding the trade-offs inherent in the design of saving programs will be a goal of future research.

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[17] Ayşe İmrohoroğlu, Selahattin İmrohoroğlu, and Douglas Joines (1998) model the institutional framework of IRAs in a general equilibrium life-cycle model and find a small effect on national saving. As they note in the paper, however, this is probably due in part to the relatively low contribution limit on the IRA.

[18] Choi, Laibson, and Madrian (2004) find, for example, that plan design has a large effect on saving behavior in the 401(k).

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7 Tables

Table 1: Coefficient estimates for income profiles

Independent variable	Edu <12	Edu 12-15	Edu >15
Working households			
FAM	0.062	0.017	0.037
	(0.016)	(0.008)	(0.010)
Age	0.201	0.099	0.029
	(0.084)	(0.045)	(0.053)
$Age^2/100$	-0.358	-0.035	-0.468
	(0.195)	(0.106)	(0.114)
$Age^3/10,000$	0.203	-0.089	0.241
	(0.145)	(0.080)	(0.079)
Constant, UE, and cohort	6.749	7.844	6.749
Retired Households			
FAM	-0.078	-0.073	0.059
	(0.029)	(0.042)	(0.088)
Age	0.000	0.015	$-.044$
	(0.000)	(0.006)	(0.008)
Constant, UE, and cohort	8.947	9.867	13.010
Error Components			
AR(1) correlation, ρ	0.698	0.665	0.698
Transitory variance, σ_ν^2	0.132	0.109	0.129
Persistent variance, σ_ε^2	0.044	0.028	0.026

Source: Author's estimates using the 1988-1997 PSID. The dependent variable is log income in year-2000 dollars. Standard errors are in parentheses.

Table 2: Displacement probabilities by age and education

Age	Edu <12	Edu 13-15	Edu >15
20-24	0.076	0.055	0.039
25-34	0.068	0.052	0.035
35-44	0.058	0.043	0.030
45-54	0.053	0.039	0.028
55-64	0.057	0.039	0.027

Table 3: Average withdrawals from the 401(k) during unemployment

Edu		$\theta = 10\%$	$\theta = 30\%$	$\theta = 50\%$	$\theta = 70\%$
< 12	$m = 0.50$	13,877	11,950	9,367	6,336
	0.25	11,473	9,758	7,141	4,757
	0	9,371	7,227	5,257	3,948
$12 - 15$	$m = 0.50$	15,862	11,541	7,568	4,472
	0.25	13,269	9,582	5,730	2,882
	0	9,870	6,959	4,265	1,138
> 15	$m = 0.50$	16,941	11,644	7,236	3,479
	0.25	13,616	8,847	4,434	2,069
	0	9,876	5,907	2,280	945

Note: Numbers are in 2000 dollars.

Table 4: 401(k) contributions and saving as a percent of non-asset income

		$\theta = 0.10$		$\theta = 0.30$		$\theta = 0.50$		$\theta = 0.70$	
Edu	Age	401(k)	Saving	401(k)	Saving	401(k)	Saving	401(k)	Saving
<12	20-29	6.06	5.94	4.31	5.32	3.17	5.06	2.10	5.03
	30-39	3.56	3.44	3.49	2.90	3.27	2.91	3.09	2.85
	40-49	7.22	4.59	6.91	5.18	6.74	5.13	6.63	5.12
	50-64	13.16	-4.72	12.76	-3.08	12.75	-2.88	12.92	-3.13
12–15	20-29	4.99	3.14	3.20	2.32	1.67	2.02	0.60	1.86
	30-39	6.03	-0.17	5.55	-0.29	5.15	-0.22	4.92	-0.15
	40-49	14.83	2.01	14.68	2.45	14.57	2.50	14.45	2.51
	50-64	15.05	-2.19	15.41	-1.78	15.58	-1.31	15.65	-1.08
>15	20-29	6.25	1.80	3.31	1.30	1.42	1.14	0.02	1.23
	30-39	2.87	1.34	2.63	1.11	2.46	1.04	2.36	0.87
	40-49	9.04	1.21	9.11	1.47	9.11	1.52	9.12	1.63
	50-64	10.60	1.17	10.88	1.82	10.98	2.09	11.10	2.26

Note: Contributions and saving ratios are conditional on employment.

Table 5: National saving rates (percent) by UI replacement rate

	$\theta = 10\%$		$\theta = 30\%$		$\theta = 50\%$		$\theta = 70\%$	
$n + g$	401(k)	No plan	401(k)	No plan	401(k)	No plan	401(k)	No plan
.00	7.1	6.0	6.3	5.2	5.6	4.5	5.0	3.8
.01	9.4	7.8	8.4	6.8	7.6	5.9	6.9	5.2
.02	10.9	9.0	9.7	7.8	8.9	6.8	8.1	6.0
.03	12.0	9.8	10.6	8.3	9.5	7.2	8.7	6.3
.04	12.5	10.2	10.9	8.5	9.8	7.3	8.8	6.3
.05	12.8	10.3	10.9	8.5	9.7	7.1	8.6	6.0
.06	12.7	10.3	10.7	8.2	9.4	6.7	8.2	5.6
.07	12.5	10.1	10.4	7.9	8.9	6.3	7.7	5.1
.08	12.2	9.9	9.9	7.4	8.3	5.7	7.1	4.5