Demographic Change, Retirement Saving, and Financial Market Returns: Part 1

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Many analysts have suggested that population aging will adversely affect the value of baby boomer's financial assets when they reach retirement. When people are working, they are more likely to be saving for retirement, purchasing assets and bidding up their price. When they retire, they are more likely to be selling assets, raising the supply of assets on the market and thereby bidding down their price. The standard analysis suggests that as the baby boom generation moves from their prime working years toward retirement, there will be important changes in their net demand for assets, with corresponding effects on asset prices. The rapidly increasing population of older people in the United States and around the world might lead to lower returns in financial markets in the decades ahead. This paper is the first part of an analysis that aims to evaluate the likely importance of demographic trends on market returns in the United States. We focus on the impact of future demographic trends on market returns that would arise from changing flows into and out of retirement saving plans, since these flows are particularly sensitive to population age structure.

Over the past two and a half decades there has been a fundamental change in saving for retirement in the United States, with a rapid shift from saving through employer-managed defined benefit pensions to defined contribution retirement saving plans that are largely controlled by employees. In 1980, 92 percent of private retirement saving contributions went to employer-based plans; 64 percent of these contributions were to defined benefit plans. By 1999, about 88 percent of private contributions were to plans in which individuals decide how much to contribute to the plan, how to invest plan assets, and how and when to withdraw money from the plan. 401(k) plans are the most important type of personal retirement account. The spread of these plans is likely to change the magnitude of age-related flows into and out of retirement plans, and it is also likely to affect the timing of these flows. Thus to understand the effect of demographic trends on the demand for retirement assets in the coming decades it is important to evaluate the likely financial flows into and out of 401(k) plans, and the corresponding account balances in these plans.

This project is part of a larger analysis that has two core components. The first involves predicting the level of assets held in retirement plans while the baby boomers are saving for retirement and when they are drawing down retirement assets after leaving the labor force. This requires evaluating not just 401(k) assets, but assets in defined benefit (DB) plans as well. While the relative importance of DB plans has declined, these plans still hold a large pool of financial assets. The second component of the larger project involves estimating the relationship between asset demand and rates of return. We plan to do this by drawing on existing estimates of how the desired holding of financial assets affects the required return, and using these estimates to evaluate how the projected changes in retirement asset holdings will affect rates of return. A companion project to this one aims to evaluate the effect of international capital flows on market returns and the results of that project will be considered jointly with this one to develop a more comprehensive understanding of the potential effects of demographic trends on rates of return.

This paper is organized into five sections. The first summarizes prior research on the relationship between demographic trends and financial market returns. The second section describes the spread of 401(k) saving programs since these saving plans first became widely available in the early 1980s. The third section describes our projection of the level of future 401(k) plan inflows and outflows. These projections require analysis of employment trends, and contribution and participation rates, as well as withdrawal patterns once 401(k) participants reach retirement. We project 401(k) net flows through 2040. The fourth section describes the implications of our projected net flows for the stock of assets in 401(k) plans in years through 2040. The last section concludes and discusses future work.

I. Previous Research on Population Aging, Financial Market Returns, and Projected Asset Demand

There is a substantial and growing literature on the link between population age structure and returns in financial markets. Several studies have used the basic framework of the overlapping-generations model to explore the theoretical effects of a transitory increase in the population growth rate, a "baby boom," on the equilibrium rate of return. These studies, while based on stylized models, have the potential to offer valuable insight on the direction of asset market effects. Other research has taken a more empirical approach and explored the reduced form relationship between summary measures of demographic structure and the returns to investors holding bonds and stocks. Very few studies have used household-level data on asset accumulation profiles to calibrate models of asset demand and to explore the impact of notional asset demand on financial market returns. The current project, which begins with disaggregate analysis of the assets in defined contribution and defined benefit pension plans, is designed to contribute to this literature.

To place the current research in perspective, it is useful to review the previous theoretical and empirical work on demographic structure and asset returns. Virtually all of the existing work adopts a closed-economy approach, either studying how an economy-wide baby boom will affect returns in that economy, or examining the correlation between a nation's population structure and financial market returns in that nation. Our survey, which draws heavily on Poterba (2005), first discusses theoretical research, and then considers empirical studies.

Abel (2001, 2003) uses an overlapping generations model with a variable supply of capital to demonstrate that a stylized "baby boom," in which the birth rate rises and then falls, reduces the rate of return relative to what it would be in a steady state economy with a stable birth rate. Individuals who are born into large cohorts therefore receive lower returns on their investments than do those born into smaller cohorts. A key result in these studies is that asset returns are affected by a baby boom even when there are altruistic intergenerational links that lead finite-lived individuals to behave as though they were infinitely lived. While these studies derive qualitative results, several other studies have used overlapping generation models to calibrate numerical intertemporal general equilibrium models that can be used to explore how changing cohort size affects asset returns. Yoo (1994a), Brooks (2002), and Geanakoplos, Magill, and Quinzii (2004) are examples of such studies, all of which suggest that a demographic transition affects capital market returns. Because the magnitude of the effect is a function of many parameter choices, it is important to explore the differences as well as similarities across studies.

Yoo (1994a) finds that a rise in the birth rate, followed by a decline, first raises then lowers asset prices. This result is quite sensitive to whether or not capital is in variable supply. With a fixed supply of durable assets, asset prices in the "baby boom economy" rise nearly 35 percent from their level in the baseline case. This translates into higher returns for those who hold assets through this period. This effect is attenuated, to a 15 percent increase in asset prices, when capital is in variable supply. In the case of variable asset supply, the return on capital varies by 40 basis points in a simulation of a "baby boom" that is loosely calibrated to resemble that in the United States during the last four decades.

Brooks (2002) develops a model in which individuals live for four periods, rather than for fifty-five periods as in most numerical OLG models. His periods therefore correspond to something longer than a decade, and the parameter choices must be set accordingly. He allows for different asset classes so that he can study the equity premium as well as the overall return on financial assets. The model is calibrated so that older individuals prefer to hold less risky assets. A short burst of rapid population growth affects the equilibrium level of both risky and riskless asset returns. Equilibrium returns on the risky asset change by roughly half as much as the riskless return, so the equilibrium equity risk premium declines in the early stage of the "baby boom," and then increases when the large cohort is old. Brooks' (2002) simulation of a rise and then decline in the birth rate that is calibrated to mimic recent U.S. history suggests that riskless returns change by about 30 basis points as a result of the demographic shift. This change persists for as long as the baby boom cohort is alive and participating in financial markets.

Geanakoplos, Magill, and Quinzii (2004) offer a sophisticated model of asset accumulation that incorporates several realistic features that are not included in earlier studies. These include realistic age-income patterns and a rudimentary Social Security system that makes the model a more accurate depiction of the post-war U.S. economy. Their core findings suggest that demographic shocks like those experienced in the post-war United States could generate substantial swings in asset values. The resulting variation in returns is not as great as the historical variation, which the authors interpret as suggesting that other omitted variables explain a large share of stock market variation. The results in this study suggest that demographic changes may have larger effects of asset values than either of the previous studies, and they suggest that it may be important to focus on the risk premium as well as the riskless rate of return.

The three simulation models just described are solved under the assumption that agents have perfect foresight about demographic shocks. Such foresight is important for analyzing demographic shocks. Since demographic shifts in the age structure of wealth-holdings occur gradually and with long lead times, it is unlikely that asset prices will fall sharply in a short period of time, for example when the largest baby boom cohorts reach retirement age. If such a decline was expected, then traders could profit by short-selling in advance of the price change, and long-term investors would benefit from shifting portfolios to short-maturity riskless assets before the price decline. Della Vigna and Pollett (2003) offer empirical evidence suggesting that stock market participants may not be fully forward looking. Future analysis of this issue may offer useful alternatives to fully rational models, but for the moment such models are the most natural group to analyze.

In most of the simulation models that have been analyzed to date, a plausibly-calibrated shock that resembles the baby boom in the United States appears to have a modest impact on asset returns. The results are nevertheless sensitive to a number of modeling assumptions and choices about parameters. This has led some researchers to study the reduced form relationship between asset market returns and population age structure. While this empirical work is helpful, it is often plagued by imprecise estimates that make it impossible to reject the null hypothesis that demographic factors have very little effect on financial markets, while also admitting the possibility of very large effects.

Most of the research to date on the correlation between demographic structure and the prices of financial assets, or the returns on these assets, has explored U.S. time series data. While the findings differ across studies, even when the underlying data sets are the same, the differences can usually be traced to differences in the econometric specification, in the estimation method, or in the sample period being analyzed.

Bakshi and Chen (1994) is one of the first careful studies of how population age structure is related to financial market returns. The analysis postulates that older individuals are more risk averse than younger ones which implies that raising the average age of the population will increase aggregate risk aversion and therefore the equity risk premium. Euler equations for aggregate consumption fluctuations fit better when the representative consumer's coefficient of relative risk aversion is allowed to vary with the average age of the U.S. population. Whether the proposed explanation for the role of this age variable is correct, however, is unresolved. Poterba (2001) suggests that survey evidence on household risk tolerance offers only limited support for the assumption that risk aversion rises with age.

Yoo (1994b) allows for a more flexible reduced-form relationship between population age structure and asset returns. The findings suggest that a higher fraction of the population in the prime saving years is associated with a lower real return on Treasury bills, but the associated standard errors are large and the point estimates of the effect are small.

Bergantino (1998) follows a more sophisticated strategy that brings together aggregate time series data on financial market returns and household-level data on asset holdings. He uses cross-sectional data from the Survey of Consumer Finances to estimate age-specific demands for corporate stock and owner-occupied real estate, and combines these estimates with data on the changing age composition of the population to create measures of aggregate demand for both corporate equity and housing. His empirical results suggest a positive association between his measure of asset demand and the level of stock prices, particularly at low frequencies. These findings are probably the strongest evidence to date suggesting a substantively important and statistically significant link between demographic changes and asset returns. Bergantino's (1998) analysis is related to Shoven and Scheiber's (1997) study of how changing demographics could affect net flows of financial assets to and from defined benefit pension plans, with corresponding effects on equilibrium rates of return.

Poterba (2001, 2005) re-examines the relationship between several measures of demographic structure and real returns on Treasury bills, government bonds, and corporate stock, emphasizing the limited number of effective degrees of freedom that results from the slow evolution of demographic structure. The results in both studies provide very limited support for a link between asset market returns and demographic variables. There is weak evidence linking population age structure to real returns on Treasury bills, as in Yoo (1994b), and some support for a link between price-dividend ratios and demographic variables. This result is similar to, although not as strong as, the finding in Bergantino (1998). For some measures of population age structure, forecasts based on the historical correlation between returns and these variables suggest implausibly large out-of-sample effects from demographic changes over the next three decades.

Geanakoplos, Magill, and Quinzii (2004) also present empirical evidence on the link between demographic structure and asset returns. This study offers evidence that the real level of share prices, measured by the S&P 500 index, is related to the ratio of middle-aged to young individuals in the population. The findings support the results of a carefully-calibrated simulation model in the same study. The key demographic variable in this analysis is the number of 40-49 year olds divided by the number of 20-29 year olds. Forecasted through 2050, the findings imply a sixty basis point decline in the expected real return on some asset classes. This study also presents evidence on the correlation between demographic structure and asset returns in other nations. The findings from abroad are not as conclusive as those based on U.S. data, but they are also more difficult to interpret because open economy factors, such as capital inflows and outflows, may play a more important role in such settings.

Several other studies have also examined the link between demographic structure and asset returns in countries other than the United States. Erb, Harvey, and Viskanta (1997) find a positive relationship in both developed and developing countries between stock returns and the change in the average age of a country's inhabitants. Their data set includes many developing as well as developed nations. The interpretation of this finding is confounded by the fact that there are many sources of variation in population age structure across nations. In many developing nations, for example, average age may proxy for changes in underlying economic conditions that reduce morbidity and mortality. It is not clear whether such demographic changes should be viewed as the driving force behind asset market movements, or whether they in turn reflect other factors at work in developing nations.

Additional cross-national results are presented by Ang and Maddaloni (2003) and Brooks (1998). The former study explores the correlation between the equity risk premium and population age structure in a number of developed nations. The study finds that country-by-country results differ substantially, and concludes that patterns that are observed in the U.S. time series often fail to generalize to other nations. The latter study exploits cross-country variation by relating the level of real equity prices to a demographic structure variable. This variable equals the ratio of the population aged 40-64 to the population older or younger than this group. For eleven of fourteen countries in the sample, there is a positive relationship between this demographic variable and the real stock price. Open capital markets pose a challenge for this research design. In countries with a substantial share of foreign investors in their equity markets, such as Denmark, Belgium, and the Netherlands, it is unclear whether domestic demographic variables should have much impact on asset returns and asset values.

Davis and Li (2003) focus on a smaller sample of seven countries with substantial equity markets. They find a statistically significant effect of the share of the population between the ages of 40 and 64 on the level of real stock prices and on real bond prices, even after controlling for a range of non-demographic factors that may affect asset prices. This strand of research may suggest a future direction for aggregate studies of asset returns and demography, namely the comparative analysis of different equity markets in different nations. Cross-border equity flows raise questions about the relevance of a single nation's age structure for its asset market, particularly in small nations.

There are now several empirical studies that suggest that demographic factors are correlated with the level of asset prices, although a sharp critic could raise challenges against each. The search for robust relationships between returns and demographic variables is therefore ongoing.

One path forward is the careful analysis of household-level data on asset holdings, and the aggregation of these holdings to provide a basis for forecasting future asset demand effects. The present paper takes a step in this direction. It builds on a number of earlier studies that have tried to project retirement asset accumulations in the future.

Holden and VanDerhei (2002a, 2002b) project the future evolution of the proportion of an individual's pre-retirement income that will be replaced by 401(k) plan accumulations. The studies simulate 401(k) accumulations by projecting the future accumulation of individuals in their 2000 database. Because their sample consists only of plan participants, their projections do not address future increase in 401(k) plan eligibility and do not allow for changes in future demographic trends. For their particular sample of participants, the authors convert 401(k) wealth to an annuity stream and compare the income generated from this annuity in the first year of retirement to earnings prior to attaining age 65.

Two studies by the Congressional Budget Office (2004a, 2004b) develop a framework to project asset flows into and out of DB, DC, and IRA plans. The analysis is based primarily on the 1997 Information Returns Master file from the IRS, supplemented with data from the Survey of Consumer Finances, Form 5500 data, and other sources. The studies project DC balances by assuming that future participation and contribution rates will equal the age-specific rates observed in 1997. These studies, like that of Holden and VanDerhei (2002a, 2002b), therefore also ignore the future spread of 401(k) plans. The authors conclude that combined DC and IRA assets will grow at the same rate as GDP through the end of the projection period (2078). Expressed as a percentage of GDP, contributions are flat at about 2 percent of GDP, investment income rises from about 5 percent in 2003 to about 9 percent in 2078, and withdrawals increase from about 1.4 percent to 6 percent over the same period. At no time are net outflows from DC and IRA plans negative.

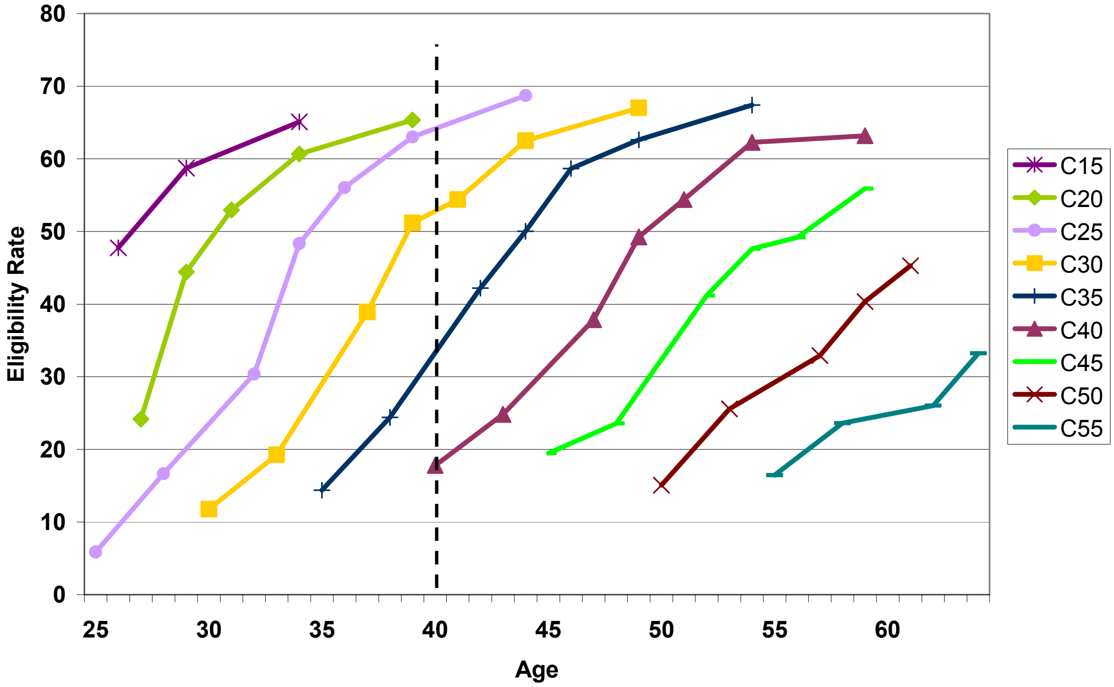
II. The Spread of 401(k) Plans Between 1984 and 2003

We now begin our analysis of the historical evolution of net flows into retirement saving plans, as a stating point for our projection of future flows. We use data from the Survey of Income and Program Participation (SIPP) to track the spread of 401(k) plans over the past two decades and to develop projections of future 401(k) assets. Various waves of the SIPP survey enable us to collect data on eligibility for and participation in 401(k) plans in 1984, 1987, 1991, 1993, 1995, 1998, and 2003. Each wave of the SIPP survey is a random cross section sample of the population. There is also a short panel component for each cross-section. The cross-section data can be used to create "synthetic" cohorts. For example, to construct cohort data for the cohort that was age 25 in 1984 we use the 1984 panel to obtain data for persons 25 in that year, the 1987 panel to obtain data for persons who were 28 in that year, the 1991 panel to obtain data for persons who were 32 in that year, and so forth. The cohort that was 25 in 1984 was 44 in 2003. We sometimes label a cohort by the age of the cohort in 1984 and sometimes by the year in which the cohort attains age 65. For example, the cohort that is age 25 in 1984 attains age 65 in 2024 and is referred to as the C25 or the R2024 cohort.

The unit of observation in the SIPP is an individual and some of the calculations are based on the individual data. For other calculations, to describe the spread the 401(k) plans for example, we have grouped the individual responses to form families. Unmarried persons are treated as single-person families and spouses are matched to recreate two-person family units. A family is eligible for (or participates in) a 401(k) plan if at least one member of the family is eligible (or participates) in a plan.

We first consider data on eligibility, organized by cohort. The SIPP provides some data for 56 cohorts. Figure 1a shows these data for 9 cohorts, five years apart, denoted by the age of the cohort in 1984. Consider

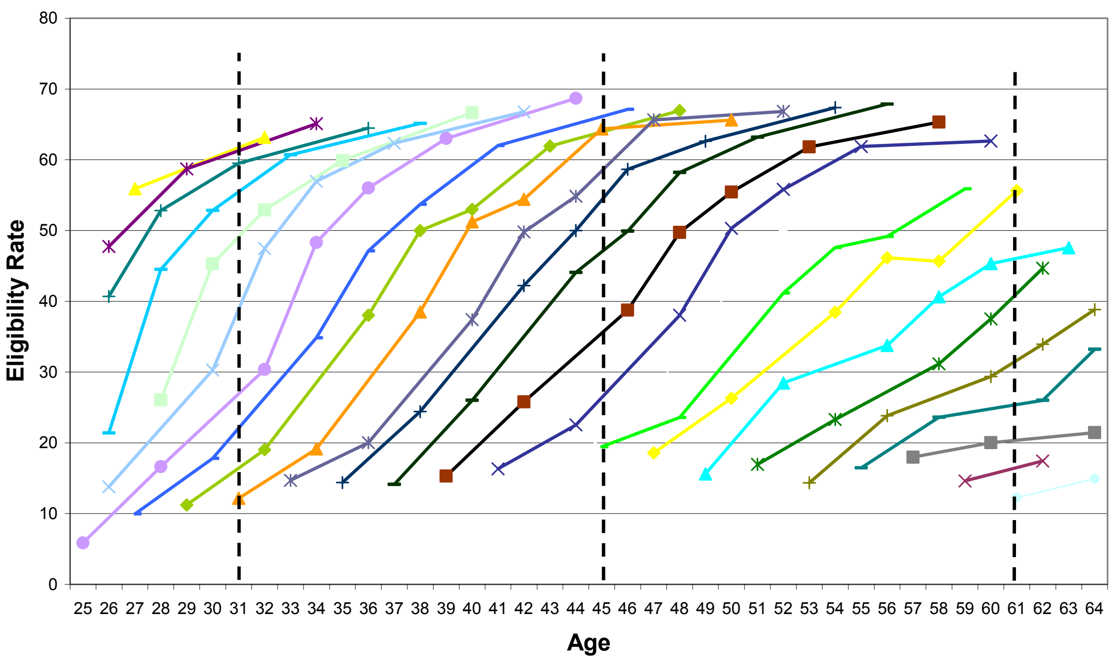
Figure 1a. Eligibility data for 9 cohorts



cohort C25 that was 25 years old in 1984. In 1984, about 6 percent of the C25 cohort families were eligible for a 401(k) plan. A family's cohort assignment is based on the age of the male "head" of the household. By 1987, the percent eligible had risen to about 17 percent. By 2003, eligibility was almost 70 percent. The most important feature of the figure is the increase in eligibility over time for families of a given age. For example, the dashed vertical line highlights the increase in the eligibility of families in cohorts that attained age 40 in successively later years. Cohort C40 was 40 years old in 1984 and about 18 percent of the C40 cohort was eligible for a 401(k) at age 40. Cohort C35 attained age 40 in 1989 and about 34 percent of the C35 cohort was eligible for a 401(k) plan at age 40. The C25 cohort was age 40 in 1999 and about 65 percent of the C25 cohort was eligible for a 401(k) plan at age 40. Similar increases in eligibility are evident at other ages.

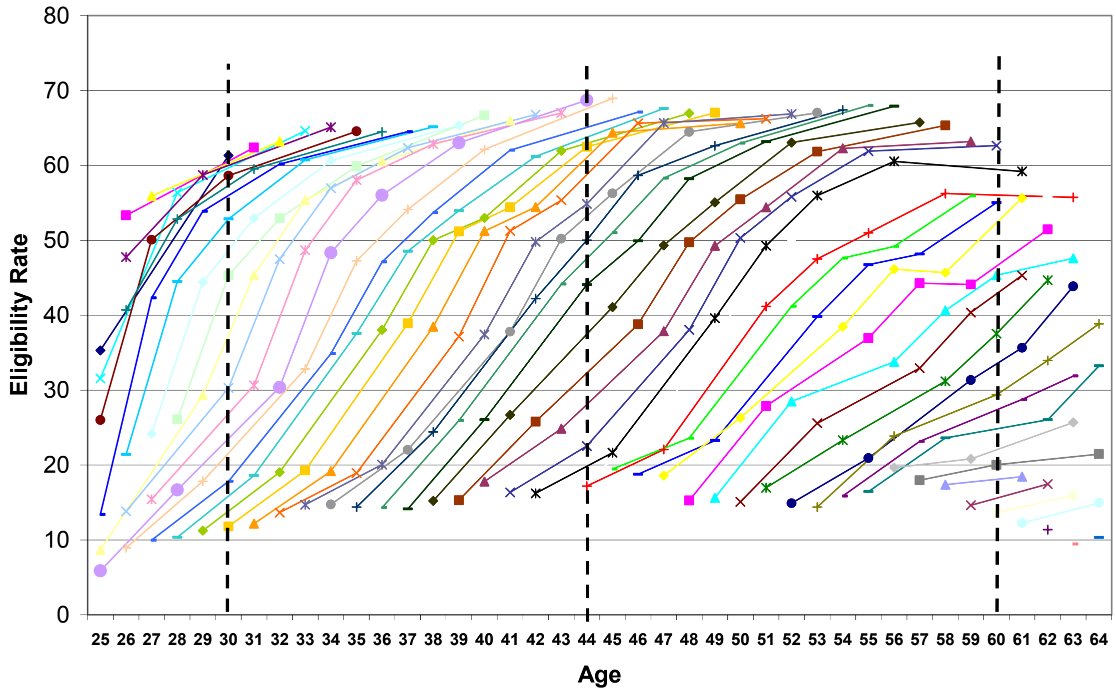
Figure 1b shows eligibility data for every other cohort for which data can be obtained from the SIPP. Figure 1c shows data for every cohort, from C11 to C64. The youngest cohorts are shown in the upper left of the figure and the oldest are shown in the upper right.[1] Again, the dashed vertical lines highlight increases in eligibility for cohorts that reached given ages in successively later years. In Figure 1b, it is clear that with few exceptions cohorts that reached a given age in successively later years had successively higher 401(k) eligibility rates. The same pattern is shown in Figure 1c, with surprisingly few "cross-overs" in the individual cohort trends even though in this figure each successively younger cohort, from bottom-right to top-left in the figure, is only one year younger than the prior cohort.

Figure 1b. Eligibility data for every other cohort



[1] Data on 401(k) eligibility are not available for persons under the age of 25 in the SIPP. The C11 cohort in Figure 1c is observed twice, once at age 25 in 1998 and again at age 30 in 2003. Cohorts younger than the C11 cohort were younger than age 25 in 1998 and are thus observed only once (in 2003). These cohorts are not shown in the figure.

Figure 1c. Eligibility data for all cohorts



The increase in eligibility rates reflects the spread of 401(k) plans to more firms and especially to smaller employers. As described in Poterba, Venti, and Wise (2004), for example, a large fraction of employers who first adopted 401(k) plans also offered DB plans; few of these employers discontinued the DB plan when the 401(k) plan was adopted. Employers who instituted 401(k) plans later were less likely to have existing DB plans and were typically smaller firms.

More important than 401(k) eligibility is 401(k) participation. Family participation rates in 401(k) plans are shown by cohort in Figures 2a, 2b, and 2c. As in the eligibility Figures 1a, 1b, and 1c, the dashed vertical lines highlight the increase in the participation rate of families who attained a given age in successively later years. For example, Figure 2a shows that only about 10 percent of the C40 cohort, those who were age 40 in 1984, participated in a 401(k) plan. But about 48 percent of the C25 cohort, which attained age 40 in 1999, participated in a 401(k) plan. More detail is shown in Figures 2b and 2c. Figure 2b shows participation rates for every other cohort and Figure 2c shows participation rates for each of the cohorts for which data are available in the SIPP.

Figure 2a. Participation data for 9 cohorts

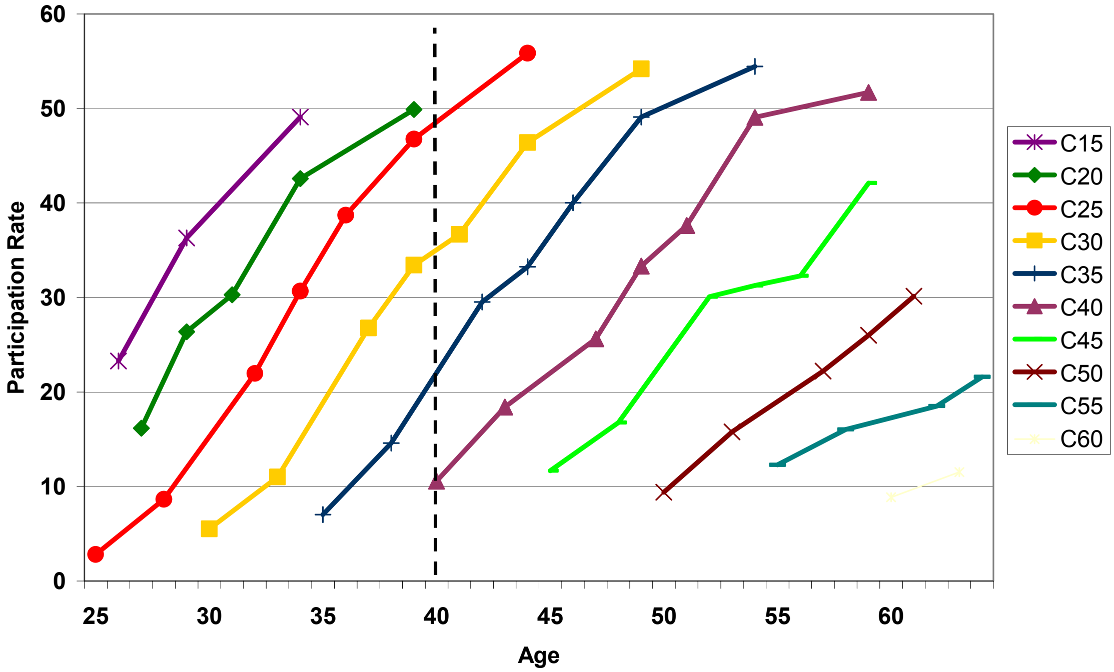


Figure 2b. Participation data for every other cohort

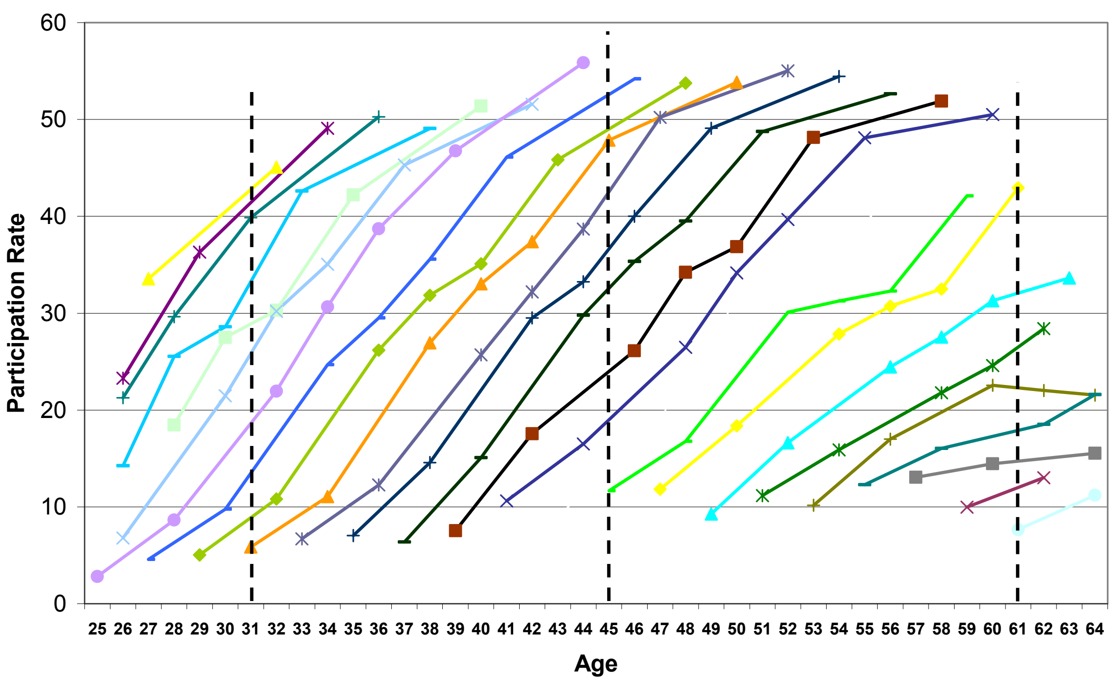
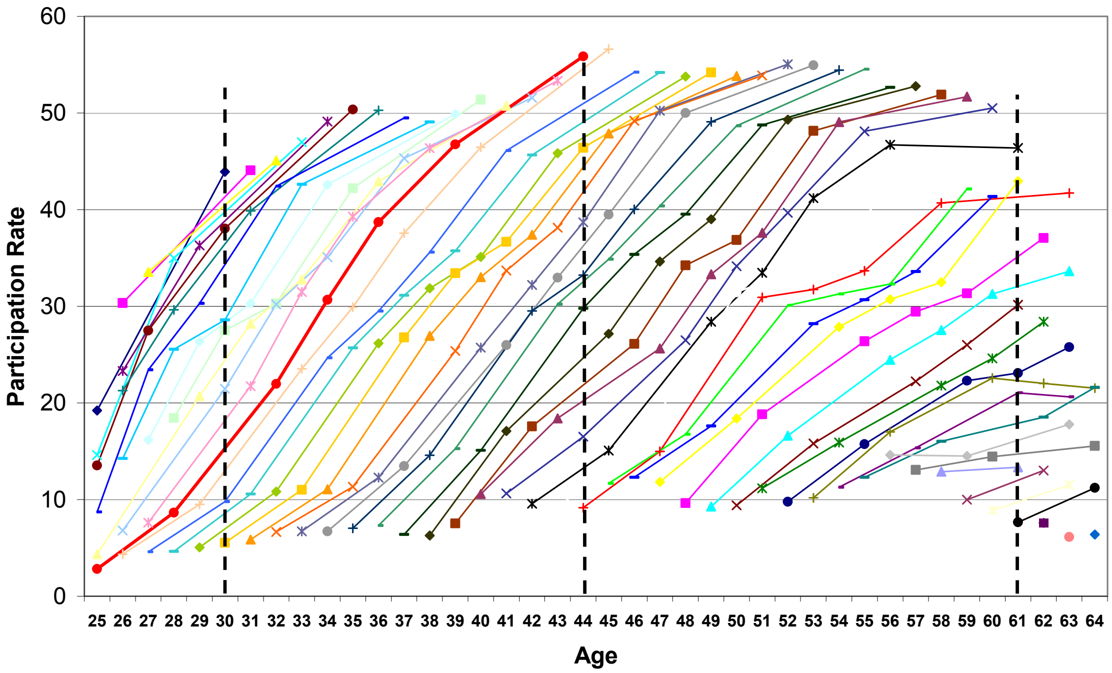


Figure 2c. Participation data for all cohorts



The cohort figures show a very large increase in 401(k) eligibility and participation rates between 1984 and 2003. In particular, cohorts that reached a given age in successively later years had successively higher eligibility and participation rates. The increase in eligibility and participation rates at selected ages between 1984 and 2003 is summarized in Table 1. The table shows the eligibility rate and the participation rate for cohorts that reached age 30, 45 and 60 in 1984 and 2003. While only 11.8 percent of the cohort that attained age 30 in 1984 was eligible for a 401(k) plan, 61.6 percent of the cohort that attained age 30 in 2003 was eligible. Only 5.5 percent of the cohort that attained age 30 in 1984 participated in a 401(k) plan, but 43.9 percent of the cohort that attained age 30 by 2003 did so.

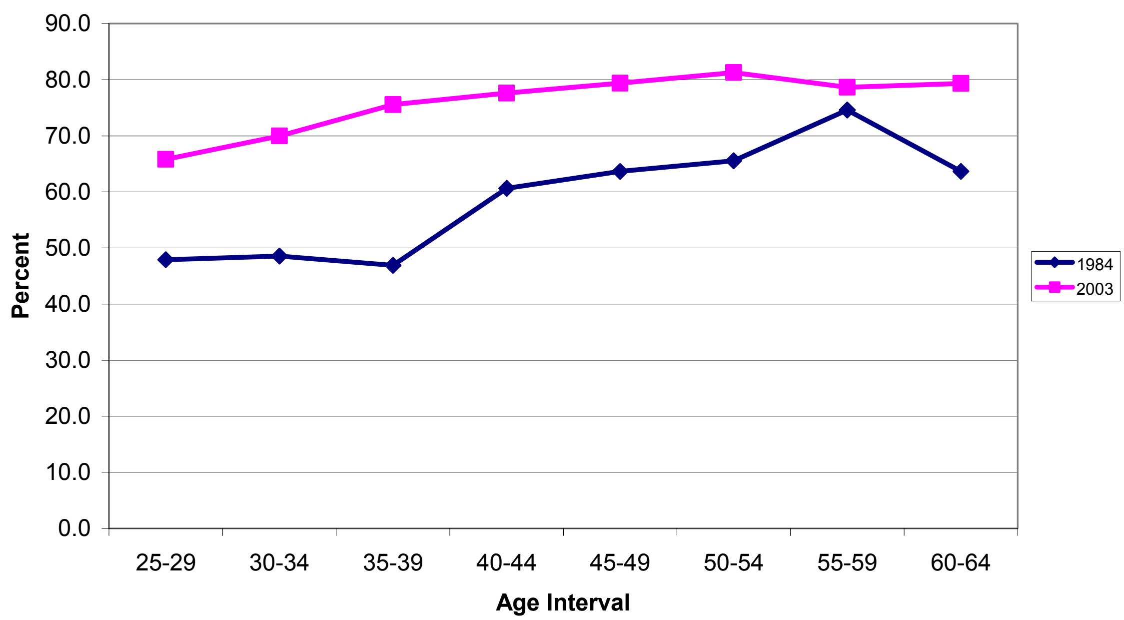
The table also shows the percent of those eligible who participated in 1984 and 2003. For each age, the participation rate given eligibility increased very substantially over this period. For example, in 1984, 46.6 percent of age-30 families who were eligible participated; this percent had increased to 71.3 percent by 2003. At age 45, participation given eligibility increased from 60.0 percent to 81.0 percent between 1984 and 2003.

Table 1. Family eligibility and participation rates by year attained selected ages (in percent)

Eligibiliy / Participation	Age 30	45	60
Eligibiliy			
1984	11.8	19.5	13.6
2003	61.6	69.9	62.6
Paticipation			
1984	5.5	11.7	8.9
2003	43.9	56.6	50.5
Participation Rate / Eligibility Rate			
1984	46.6	60.0	65.4
2003	71.3	81.0	80.7

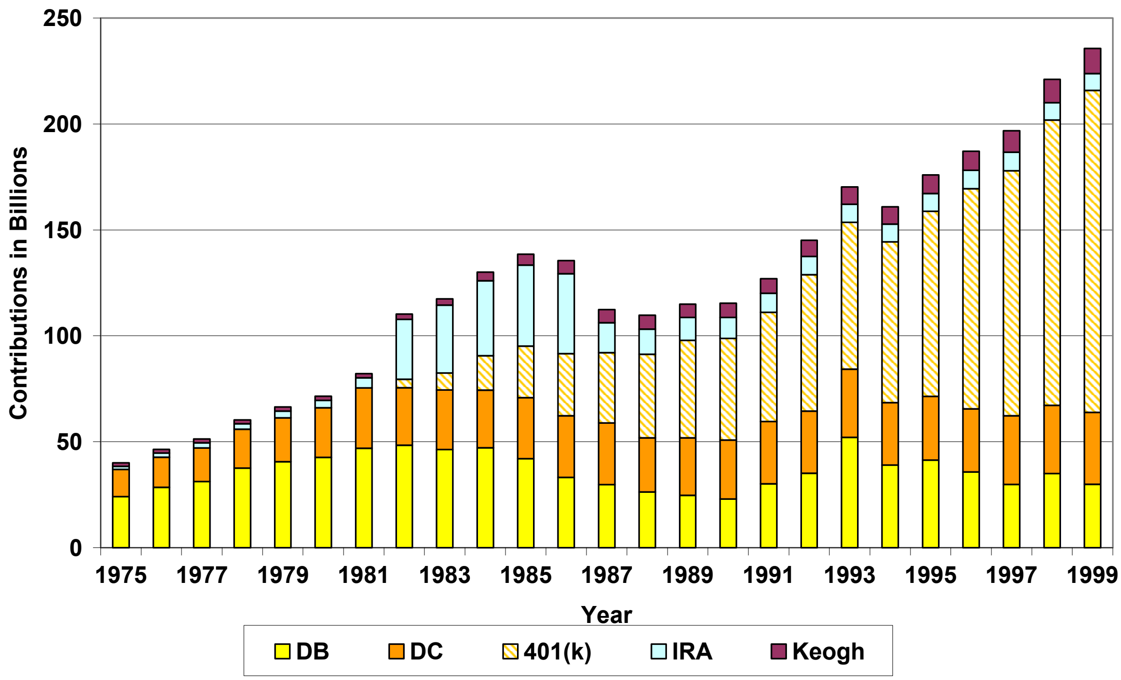
More detail on participation given eligibility is shown in Figure 3. The figure shows that, given eligibility, the participation rate increased for each age interval, especially for the younger age intervals. The figure also shows that in 2003 the participation rate given eligibility was about the same (80 percent) for each of the age intervals from 40-44 to 60-64. The data also suggest that participation rates given eligibility are higher for successively younger cohorts.

Figure 3. Participaton percent given eligibility by age, 1984 and 2003.



The rapid spread of 401(k) eligibility and participation rates has resulted in very rapid growth in aggregate contributions to 401(k) plans. Figure 4 shows contributions to 401(k) plans and, for comparison, to all other private pension plans from 1975 to 1999.[2] Contributions to 401(k) plans are shown by the lined bars. Contributions to 401(k) plans were first made in 1982. By 1999 total contributions to 401(k) plans had reached $152 billion and accounted for 65.5 percent of contributions to all private pension plans.

Figure 4. Private Pension Contributions



The increase in total pension plan contributions between 1982 and 1999 was accounted for almost entirely by the increase in contributions to 401(k) plans. Contributions to defined benefit (DB) plans fluctuated substantially over this period, but were about $17 billion, or 36 percent, lower in 1999 than in 1981. Contributions to non-401(k) defined contribution (DC) plans changed little between 1981 and 1999. There was a substantial spike in IRA contributions in 1982 through 1986. Thereafter IRA contributions fell by about 75 percent, when the tax advantage of IRA contributions was reduced for a small proportion of contributors. Since 1987, the sum of IRA and Keogh plan contributions has changed very little. Most of the inflows to IRAs today are roll-overs of previous accumulations in defined contribution accounts, rather than traditional contributions.

III. Projecting Future 401(k) Contributions

The stock of wealth held in retirement accounts is likely to be more sensitive to demographic trends than other components of household net worth, since retirement accounts are

[2] More recent data from Form 5500 files are not available.

at least in principle dedicated to providing financial support in retirement. Funds are contributed to these accounts only when the account-holder is working, and they can be withdrawn without penalty only after the accounted-holder is close to, or older than, typical retirement ages. If an account-holder reaches age 70½, minimum distribution requirements specify withdrawals from these accounts. The balances in these accounts will therefore tend to increase when the large birth cohort is working, and to decline when they leave the labor force, but the timing of the withdrawals in particular is uncertain.

Assets in retirement accounts comprise a large share of financial assets in the United States. In 2003, 28 percent of equities was held in pension plans Another 16 percent was held in mutual funds and 10 percent by insurance companies; some of these holdings are also related to retirement saving and could also be affected by future demographic patterns.

Prior to the recent expansion of defined contribution plans, the accumulation of retirement assets in the United States was traditionally through employer-provided DB pension plans. The decumulation of these assets was managed through retirement annuities provided by employers to their retirees. This structure implies relatively tight links between the flow of funds into DB pension funds, the number of future employees covered by DB plans, the contribution per employee to such plans, and on the return earned on DB pension investments. Schieber and Shoven (1997) recognized the link between the age structure of the population and the net inflows to private DB pension plans, and they suggested that historically positive inflows would reverse, and the pension sector would switch from a source of accumulation to a source of decumulation, when the baby boomers retire. They further suggested that such a reversal could affect asset prices.

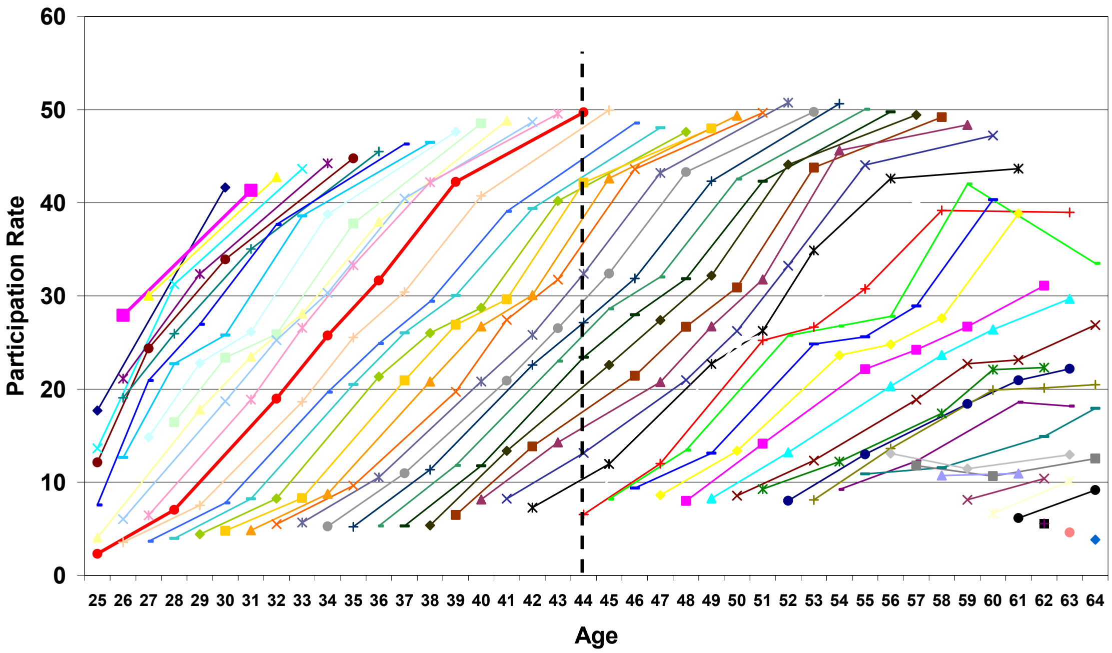
The mechanical nature of the accumulation and draw-down of assets in defined benefit pension plans facilitates projecting future contribution flows and asset holdings. Projecting DB plan accumulations is only part of the challenge in evaluating the prospective link between demographic change and asset holdings. We also need to project future defined contribution plan balances; this is more challenging, but also very important, since 88 percent of private pension plan contributions in 1999 were to 401(k) plans and other personal retirement accounts. We now describe the general features of the method we use to project contributions to 401(k) plans.

Participation rates: We begin with historical participation rates by cohort, like those shown above, except that we use individual rather than family data. The SIPP provides data for cohorts attaining age 65 in 1985 through 2040. The most recent data are for 2003 and the earliest data are for 1984. Only a few of the cohorts (shown in the bottom right of Figures 1 and 2 above) had attained age 65 by 2003. Thus for all but a few of the cohorts we must project participation rates from the cohort age in 2003 to age 65.

The participation rate is the eligibility rate times the participation rate given eligibility. We project each of these rates separately and then combine the two to project participation. The future eligibility rate will depend in particular on the spread of 401(k) plans to small employers. We know from the foregoing figures that eligibility rates have increased very rapidly over the past two decades, and that participation, given eligibility, increased substantially over the 1984 to 2003 period. We have not found a compelling way to formally project future rates of eligibility or participation conditional on eligibility. Thus we have simply made "plausible" assumptions about future participation rates and used them to project future cohort participation rates for the cohorts covered in the SIPP data.

Simple extrapolations of the cohort data are likely to yield implausibly large participation rates. The cohort participation data for persons are shown in Figure 5. Consider, for example, the participation rates at age 44 highlighted by the vertical dashed line. The C44 cohort attained age 44 in 1984 and had a participation rate of 6.6 percent at that time. The C25 cohort attained age 44 in 2003, 19 years later, and had a participation rate of 49.7 percent. On average, the participation rate at age 44 increased 2.27 percentage points with each successively younger cohort. Were this rate to continue, the participation rate of the C12 cohort at age 44 (that the C44 cohort will attain in 2016) would be 79.2 percent (13 x 2.27). We suspect that this estimate of the future participation rate is too high, because 401(k) plans have already diffused through the segments of the corporate population that have workforces that find these plans most attractive, and that have the lowest per-employee administrative costs of implementing a plan.

Figure 5. Person Participation Rate by Cohort



Estimation of cohort effects shows some compression with successively younger cohorts. In addition, Figure 5 suggests that within cohorts, the increase in participation rates was lower between the last two data points for each cohort, 1998 and 2003, than for earlier intervals of comparable length.

To recognize the apparent compression in the cohort effects and the apparent decline in the rate of within cohort increase in participation rates, we make future projections for each cohort based on its observed 2003 participation rate. We assume that the annual increase in future participation rate will be smaller than that between 1998 and 2003. In particular, we assume that the future annual rate of increase declines by 0.12 percent per year. With this assumption, the projected future participation rates for the C25 and the C12 cohort would be as shown in Figure 6, which also shows the actual participation rates for these cohorts in 2003 and earlier years. Based on these projections, the participation rate of the C12 cohort when it attains age 44 in 2016 would be 66.3 percent, compared to 49.7 percent for the C25 cohort, which attained age 44 in 2003. At age 64, the participation rate would be 62.6 percent for the C25 cohort and 74.4 percent for the C12 cohort.

Figure 6. Projected participation rates for cohorts C25 (R2024) and C12 (R2037)

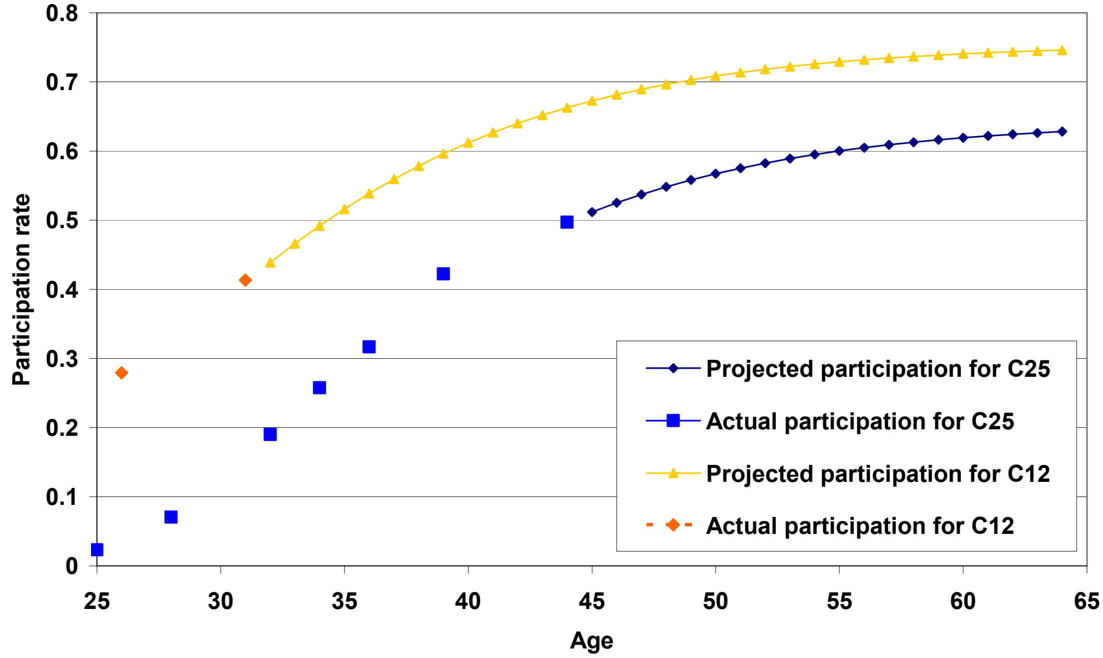


Figure 7. Interpolated (1982-2003) and projected (2004-2040) participation rates for selected cohorts

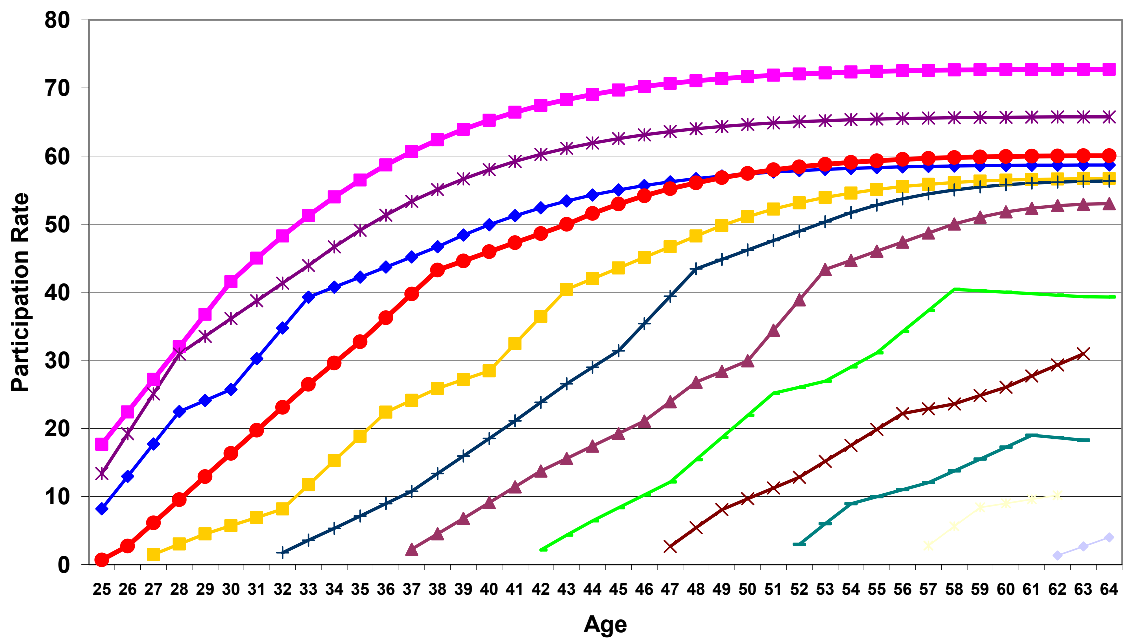


Figure 7 shows the projected participation rates of selected cohorts from C11 (R2038) to C64 (R1985). The figure also shows the interpolated participation rates between the years for which data are available prior to 2003.

Rate of Return: We assume that 60 percent of contributions are allocated to large-capitalization equities and 40 percent to corporate bonds. The projections use actual annual pre-tax returns through 2003. Beginning in 2004 we assume that the average annual nominal return on equities is 12 percent and that the average nominal return on corporate bonds is 6 percent. Ibbotson Associates (2004) reports that the historical arithmetic mean of pretax returns on long-term corporate bonds has been 6.2 percent per year, while large-capitalization stocks have returned an average of 12.4 percent over the period 1926-2003. These returns are the pretax returns available on a portfolio with no management fees. We have not as yet accounted for asset management fees. The average dollar weighted management fee on stock funds is currently about 70 basis points.

The OASDI Trustee's report for 2005 projects an inflation rate of 2.8 percent over the period that corresponds to our forecasts. By comparison, the average inflation rate over the time period that we use to measure historical asset returns was 3.0 percent. Thus our projections assume real rates of return over the next several decades that are roughly comparable to those recorded over the last eight decades. Because projected asset balances in 401(k) plans are sensitive to rate of return assumptions, in future work we plan to present sensitivity analysis allowing for alternative rate of return scenarios.

Job Separation and Lump Sum Distributions: At age 25 each person is assigned to a 401(k) job based on the participation probability for that person's age and cohort. In subsequent years each person either remains in the 401(k) job or leaves the 401(k) job. The quit probabilities vary by age, but not by time in the job. The job separation rates are 6.0 percent per year for ages < 35, 4.5 percent for ages 35-45, 4.0 percent for ages 45-55, and 5.0 percent for 55+. After leaving a 401(k) job persons enter a pool of "non-participants." In each year members of this pool are selected for a new 401(k) job at a rate that makes the overall participation rate for persons of a particular age and cohort equal to the projected probability for that age and cohort. A similar projection algorithm, with an identical treatment of transitions in and out of 401(k) participation, is described in Poterba, Venti, and Wise [2001].

We also allow for participants to cash out 401(k) balances at the time of a job change. The likelihood of a lump sum distribution is related to the 401(k) balance at the time of separation. A small balance, less than $2,460 in 2000 dollars, is cashed out 60 percent of the time. A large balance, over $123,000 in 2000 dollars, is cashed out only about 3 percent of the time. The detailed cash out probabilities are drawn from Table 1.3 of Poterba, Venti, and Wise [2001].

Withdrawals: The projections reported here assume a crude withdrawal scheme. Annual withdrawals are assumed to be 2 percent of balances between ages 65 and 71 ½. At older ages, the amount withdrawn from the 401(k) is (1/Remaining Life Expectancy) times the 401(k) balance. We are currently exploring withdrawal rates in the Health and Retirement Survey (HRS) data.

Earnings: To estimate the 401(k) contributions of a cohort, we need to determine the earnings and the contribution rates of cohort members. The key to developing an earnings history is access to a long time series of earnings by a single individual or family. Unfortunately, such earnings histories are not available for SIPP participants. We therefore exploit another data set, the HRS, which has linked earnings histories from Social Security records with the survey responses for some participants. These data represent earnings histories for a sample of individuals who were between the ages of 52 and 61 in 1992. The strong implicit assumption in our analysis is that the earnings trajectory for these cohorts are similar to that younger cohorts,

To develop earnings histories we begin with the Social Security earnings histories of the HRS respondents, available for the years 1961 through 1991.[3] Earnings for 1992 through 2000 are obtained directly from HRS respondents. We begin with the earnings of the cohorts that attained age 65 in 1998, 1999, and 2000. We obtain lifetime earnings for all single persons that attained age 65 in these years and for all persons in two-person families in which the male partner attained age 65 in these years. The earnings of the 1998 cohort are "aged" two years and the earnings of the 1999 cohort are age one year, based on the Social Security average wage index. We then treat these earnings histories as a random sample of the earnings of the cohort that attained age 65 in 2000 (the "R2000" cohort). The sample reports actual earnings histories, including years with zero earnings, so it recognizes that individuals may not be employed in some years. We implicitly assume that the employment rate and the distribution of employment by age are similar for future cohorts as for past ones. Note that the "R2000" cohort contains some female spouses who were not 65 in 2000.

To make projections for the earnings of younger cohorts, we inflate the "R2000" sample using the intermediate earnings assumptions reported in the 2005 Annual report of the Board of

[3] We used a two-limit tobit specification (with a separate equation for each year) to impute SS earnings for persons censored at the upper Social Security earnings limit.

Trustees of the Social Security Administration. Similarly, to project a sample of earnings for older cohorts we deflate the earning of the "R2000" cohort based on the Social Security average wage index. This method does not account for any potential change in the relative earnings of high and low-wage persons.

Contribution Rate: We assume a contribution rate of 9 percent of earnings, including both the employee and the employer contributions. There are several sources of information on contribution rates. Data from the 2003 SIPP are shown in Table 2. The median of the total of the employee and the employer rate is 9.8 percent. The mean rates are higher, although the means may be substantially affected by reporting errors.

In Poterba, Venti, and Wise (1998), we estimated contribution rates based on the 1993 Current Population Survey (CPS). The average contribution rate of an individual employee was 7.1 percent and the average employer rate was 3.1 percent. Earnings-weighted family contribution rates, averaged over rates for both members of a two-person family, for example, were 6 percent for employees and 2.7 percent for employers. The average earnings-weighted total family contribution--counting both employee and employer contributions—was 8.7 percent.

Holden and VanDerHei (2001) analyze the responses to an Employee Benefit Research Institute (EBRI)-Investment Company Institute (ICI) survey and report that in 1999 the average total contribution rate was 9.7 percent. The 1998 Form 5500 shows that about 32 percent of dollars are contributed by employers, which is roughly consistent with the 1998 SIPP median percent and with the 1993 CPS values. These sources of information suggest that the 9 percent contribution rate we assume here may be too low. Moreover, since contribution limits to 401(k) plans have increased since 2001 and will continue to increase in the next several years, the average contribution rate for future cohorts is likely to be higher than that for past cohorts. The changes in both 401(k) and other personal retirement accounts are summarized in an appendix.

Table 2. Employee and employer 401(k) contribution rates as a percent of salary, for individuals, based on 2003 SIPP

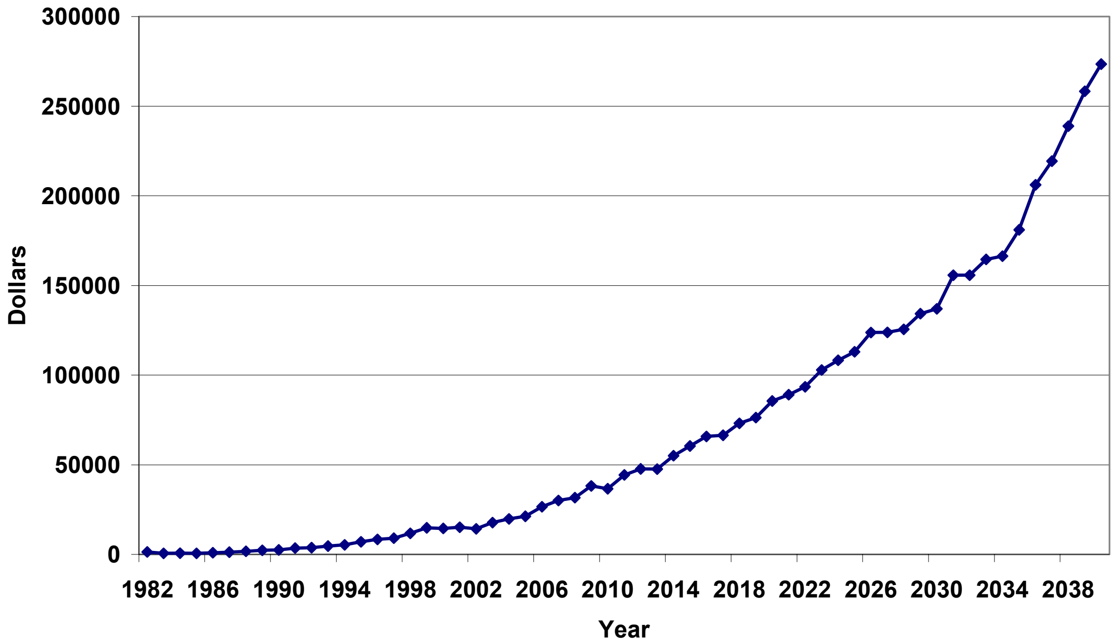
Age	Employee		Employer		Total	
	Mean	Median	Mean	Median	Mean	Median
25 - 29	6.8	5.0	4.6	3.0	11.4	9.0
30 - 34	7.7	5.2	4.6	3.0	12.4	9.3
35 - 39	7.9	5.8	4.7	3.0	12.5	9.7
40 - 44	7.8	5.7	4.6	3.0	12.4	10.0
45 - 49	8.0	6.0	4.8	3.0	12.8	10.0
50 - 54	8.6	6.0	4.3	3.0	13.0	10.0
55 - 59	9.1	6.0	4.6	3.0	13.7	10.0
60 - 64	8.7	6.0	4.6	3.0	13.3	10.0
All	8.0	5.7	4.6	3.0	12.6	9.8

IV. Assets in 401(k) Plans by Cohort and Total Assets by Year

We obtain the number of persons at each age, by family status, for each year from demographic projections developed by the Office of the Actuary of the Social Security Administration. These demographic data, combined with the projected participations rates, earnings and contribution rates, and rates of return, can be used to project 401(k) assets at each age for each cohort. These projections can in turn be aggregated to estimate the aggregate 401(k) assets at each year in the future. We limit our projections to the period between 2006 and 2040. These projections are a key component of the aggregate level of retirement assets that may affect the rate of return on financial assets in the future. The data can also be used to describe other aspects of 401(k) saving, such as the average 401(k) assets at age 65 for each cohort. We consider the 401(k) assets of cohorts at retirement first and then turn to the aggregate level of 401(k) assets by year.

401(k) Assets at Retirement: The average per person 401(k) assets at age 65 (in 2000 dollars) is shown in Figure 8, for cohorts R1982 to R2040. The projected average increases very substantially over the next 35 years. The average is \$14,445 in 2000, \$85,881 in 2020, and \$273,418 in 2040. The projected increase is due to the increase in the participation rates among more recent cohorts and to the increase in the number of years that 401(k) plans were available to successive cohorts. The 401(k) program effectively began in 1982 so cohorts retiring before 2020 could only make contributions over part of their working lives. Persons who attained age 65 in 2000 could have contributed to a 401(k) plan for at most 18 years. For the cohort that will attain age 65 in 2040, 401(k) plans will have been available over the entire working lives of many employees.

Figure 8. Mean 401(k) assets at retirement, by cohort, for persons (in 2000 dollars)



These projected 401(k) assets at retirement can be compared with DB assets of recent retirees. Based on HRS data, Johnson, Burman and Kobes (2004), for example, estimate that the mean present value of employer sponsored pension income for persons 65 to 69 in 2000 was $50,203. Our projected 401(k) wealth at age 65 reaches this level in about 2014 and thereafter increases to much higher levels (in 2000 dollars).

To check our projection algorithm, we compared our estimate of the mean 401(k) assets of persons who attained age 65 in 2000 with the mean 401(k) assets of HRS respondents who attained age 65 in 2000. The HRS mean is $15,937, compared to our projected mean of $14,445. Thus by this measure our projection algorithm may undervalue 401(k) assets in the near future.

Total 401(k) Assets by Year: The foregoing projections are based on the accumulation and decumulation of 401(k) assets by persons in cohorts R1982 through R2040. To project aggregate assets by year through 2040, however, requires that we also account for the accumulation of assets by younger cohorts. For example, the aggregate level of 401(k) assets in the year 2040 is the sum of the assets of cohorts R2005 through R2040 plus the assets of cohorts R2041 through R2080. The R2080 cohort will be age 25 and just starting to contribute to 401(k) plans in the year 2040. Thus we must assume a 401(k) participation rate for the younger cohorts. For the results below we assume that the participation rates of the R2041 to R2080 cohorts are the same as those for the R2040 cohort.

Figure 9. Total 401(k) stock assets in each year (in millions of year 2000 dollars)

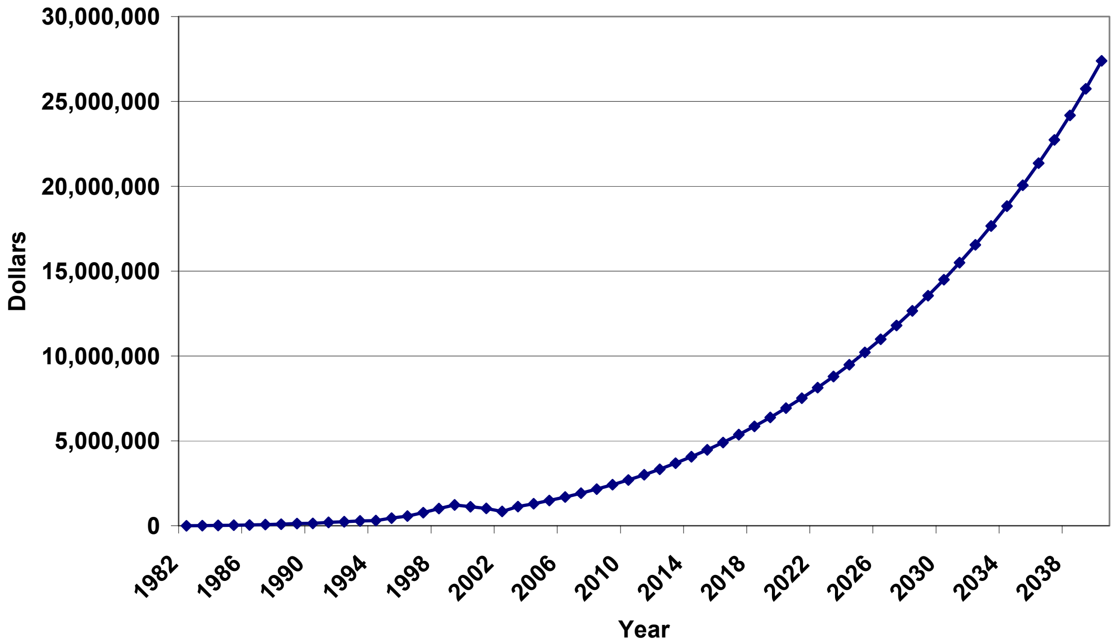


Figure 9 shows projected total 401(k) assets in stocks for the years 1982 to 2040. Total equity assets are projected to grow from about $1.12 trillion in 2000 to about $27,38 trillion in 2040. We can provide some check on our algorithm by comparing our projected assets in 1999 with assets reported in Form 5500 data for 1999. In 1999, our projected level of total assets—including both stocks and bonds—is $1.622 trillion (in 2000 dollars), compared to the Form 5500 total of $1.853 trillion (in 2000 dollars).[4]

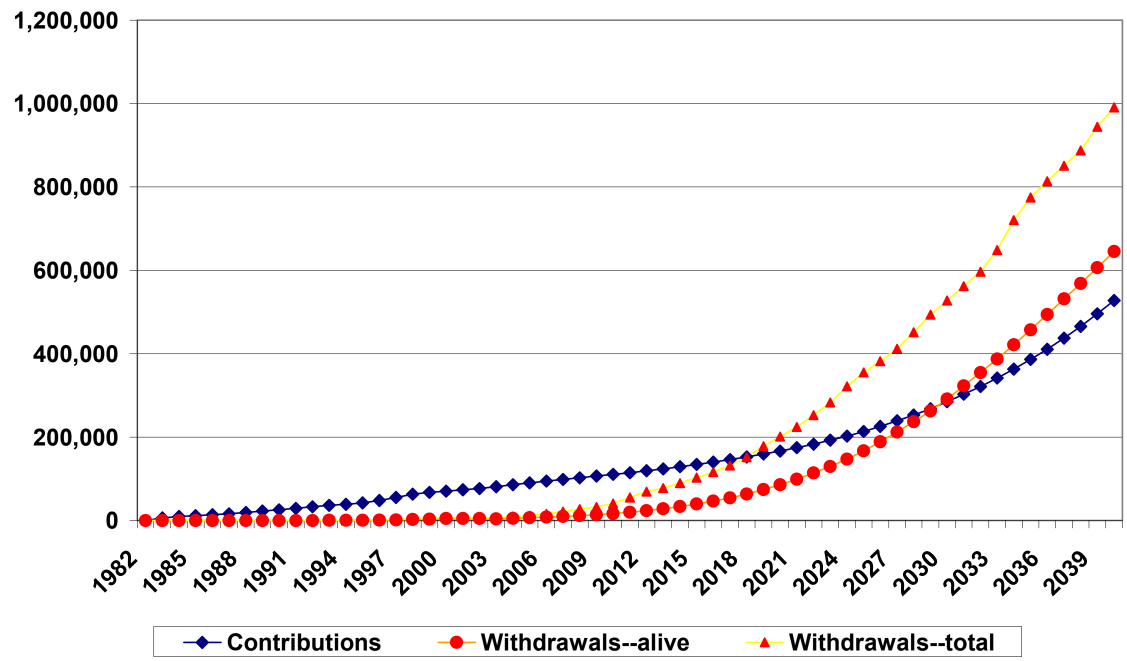
Figure 10 shows contributions and withdrawals of stocks in 401(k) accounts over the same time period. Contributions exceed withdrawals of living participants until about 2029; if balances at death are treated as "withdrawals," contributions exceed withdrawals until about 2018. Again, we can compare our projected contributions to contributions reported in Form 5500 data. In 1999, our projected total—including both stocks and bonds—is $112.3 billion (in

[4] In earlier years, the Form 5500 totals are much larger than our projections and apparently include assets in some non-401(k) accounts. Andrews (1992) reports that when IRS 401(k) regulations were issued in 1982, many employers converted after-tax thrift-savings plans to 401(k) plans to give their employees the benefit of pre-tax contributions. In addition, some 401(k) assets are rolled over into IRA accounts. The CBO (2004b) reports these rollovers totaled $107.8 billion in 1998, $136.6 billion in 1999, $151.5 billion in 2000, and $130.1 billion in 2001. Our projected asset levels do not account for rollovers and thus some assets that would have been rolled over into IRA accounts. The Form 5500 assets include only 401(k) assets. Thus, in this respect, our projections should in fact be greater than the Form 5500 assets in a given year.

2000 dollars), compared to the Form 5500 reported level of $157.3 billion. We will consider further the possible explanations for these differences.

Whether the change in the net contributions to 401(k) plans, and thus in the growth of 401(k) assets, is likely to have an appreciable effect on equity prices depends on the importance of this change relative to the size of the total equity market. For example, in 2004 the value of all corporate equities was about $17.4 trillion and the value of 401(k) projected equities was about $1.30 trillion. By 2040 we project that 401(k) equity holdings will have increased to over $27.38 trillion, in 2000 dollars. The total value of all equities in 2040 is uncertain, but our calculations suggest that 401(k) holdings will be a growing share of the total market.

Figure 10. Stock contributions and withdrawals (in millions of 2000 dollars)



V. Conclusions, Comments, and Future Work

This paper presents results from the first stage of a project on the potential effect of demographic trends on market rates of return. We describe the rapid rise of 401(k) plans between 1982 and 2003. We then project the 401(k) assets of cohorts who will reach age 65 in future years, through 2040, and the assets of cohorts who will reach age 65 in 2041 through 2080. From these cohort projections we project the aggregate level of 401(k) assets for each year through 2040. We will next project the level of DB plan assets over the same time period, and then the level of assets in other retirement plans such as IRAs, Keoghs, and 403(b)s. Those projections should enable us to evaluate the potential effects of demographic trends on rates of return in financial markets.

We also used the data to project the assets at age 65 of cohorts who reach age 65 in each year from 1982 to 2040. These estimates are of considerable interest independently of the effect of the changing level of retirement assets on financial market rates of return. We find that by 2040 the mean level of 401(k) assets of persons retiring in that year will be $363,331 (in 2000 dollars), compared to $14,760 in 2000.

We have not taken account of the recent and prospective changes in 401(k) contribution limits that will also affect flows into 401(k) accounts. In addition, unlike many traditional DB pension plans, personal retirement plans do not encourage early retirement. Thus employees are likely to work longer under these plans and to continue to make contributions to the plans for more years than would be the case with employer contributions to DB plans. This shift to longer working careers and a corresponding change in the length of the retirement period will likely increase the total amount of retirement asset accumulation in the 401(k) regime. .

Unlike the retirement annuities provided under DB plans, retirees with accumulations in personal accounts have substantial flexibility in how they choose to draw down their assets. Very few retirees buy annuities with assets accumulated in personal accounts. Thus there is no scheduled withdrawal of funds from personal accounts. Current law requires retirees to begin making minimum distributions from traditional 401(k) plans at age 70½. Despite the multitude of decumulation options, there has been little empirical analysis of when retirees actually begin withdrawals and how rapidly they draw down their account balances. We will give more attention to this issue in future work, and as new data enable us to analyze decumulation.

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Appendix on Tax Legislation and Retirement Saving Options: 401(k) and Other Personal Retirement Accounts

Both the Taxpayer Relief Act of 1997 and the Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA) included provisions that were designed to induce more retirement saving, principally through tax-deferred accounts. These bills established Roth IRAs and increased contribution limits to traditional IRAs, 401(k)s, and other personal accounts. EGTRRA also introduced tax credits for low-income taxpayers who make contributions to IRAs, Roth IRAs, 401(k)s, and other personal accounts. We begin by describing some of the more important recent changes to the IRA and 401(k) programs.

Roth IRA: The Roth "back-loaded" IRA was introduced in 1997. Contributions to the Roth IRA are not tax deductible, but no tax is paid upon withdrawal if the funds are held for at least five years and if the recipient is over age 59½. Like the "front-loaded" (traditional) IRA, the investment return in a Roth IRA accrues tax-free. Contribution limits and allowances for penalty-free withdrawals are the same as for the traditional IRA. However, the Roth IRA contribution limit is specified in after-tax dollars whereas the traditional IRA limit is in pre-tax dollars. One consequence of this difference is that the potential accumulation of retirement saving is higher under the Roth IRA. In addition, the income at which eligibility begins to be phased-out is much higher for the Roth IRA ($95-110,000 for single persons and $150-160,000 for married couples) than for the traditional IRA ($34-44,000 for single persons and $54-64,000 for married couples). The phase-out ranges for both types of IRAs are set to increase each year through 2007.

Contribution Limits for IRAs: Contribution limits to a traditional IRA were originally set in 1981 at $2,000 per working spouse and $250 for a nonworking spouse. A provision in the Small Business Job Protection Act of 1996 raised the deduction available to a non-working spouse from $250 to $2,000 effective in 1997, thus increasing the combined deduction for a family with a non-working spouse from $2,250 to $4,000. Contribution limits for the Roth IRA, established by the 1997 legislation, were also $2,000 per spouse. The 2001 legislation increased the contribution limits for both the traditional IRA and the Roth IRA. The new limit is $3,000 for 2002 and 2003 and is increased to $4,000 for 2005 to 2007. The limit will be raised to $5,000 in 2008 and thereafter it will be indexed to inflation.

Catch-up Contributions for IRAs: The catch-up provision in the 2001 legislation allows persons age 50 of older to contribute an extra $500 per year in 2002 to 2005 and an extra $1000 per year beginning in 2006. This feature applies to both traditional and Roth IRAs.

Contribution Limits for Employer Plans: For 2003, the 401(k) contribution limit was 15% of earnings or $12,000 annually, whichever is smaller. The limit will increase $1,000 each year until 2006, when it will be $15,000. Thereafter the limit is indexed to inflation in increments of $500. In addition, employers will be able to add as much as 25 percent of earnings on top of the employee contribution.

Catch-up Contributions to Employer Plans: As with IRAs, there is also a 401(k) catch-up provision for participants age 50 or older. The allowable catch-up contribution was $1,000 for 2002, and it increases in steps under existing legislation until it reaches $5,000 in 2007. After 2007, the catch-up amount is indexed to inflation.

Saver's Tax Credit: Beginning in 2002 and continuing until the end of 2006, taxpayers who make contributions to personal retirement saving plans—401(k), 403(b), 457(b), traditional or Roth IRAs, and other plans—may receive a tax credit of up to 50 percent on the first $2,000 contributed. Eligibility for the deduction is determined by income. For joint tax filers, the deduction is 50 percent for those with incomes less than $30,000 and is phased out at $50,000. For single tax filers the deduction is 50 percent for those with incomes less than $15,000 and is phased out at $25,000.

Recently legislated changes in 401(k) contribution limits are illustrated in Appendix Figure 1. Household income is on the horizontal axis and the contribution limit is on the vertical axis. The largest 401(k) limit increases are for persons with incomes between $15,000 and $20,000. Very few persons with incomes in this range are currently contributing the maximum. However, as incomes increase a larger and larger fraction of employees are likely to be contributing at the new limits.

Appendix Figure 1. Maximum contribution to 401(k) plans by Income: 2003 and 2007