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POPULATION AGE STRUCTURE AND ASSET RETURNS: AN EMPIRICAL INVESTIGATION

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ABSTRACT

This paper investigates the association between population age structure, particularly the share of the population in the "prime saving years" 45-60, and the returns on stocks and bonds. The paper is motivated by the claim that the aging of the "Baby Boom" cohort in the United States is a key factor in explaining the recent rise in asset values. It also addresses the associated claim that asset prices will decline when this large cohort reaches retirement age and begins to reduce its asset holdings. This paper begins by considering household age-asset accumulation profiles. Data from the Survey of Consumer Finances suggest that while cross-sectional age-wealth profiles peak for households in their early 60s, cohort data on the asset ownership of the same households show a much less pronounced peak. Wealthy households with substantial asset holdings appear to decumulate slowly, if at all, after retirement. This casts doubt on the "asset sell off" view, at least for the share of assets (excluding defined benefit pension assets) that households control directly. The paper then considers the historical relationship between demographic structure and real returns on Treasury bills, long-term government bonds, and corporate stock. The results do not suggest any robust relationship between demographic structure and asset returns. This is partly due to the limited power of statistical tests based on the few "effective degrees of freedom" in the historical record of age structure and asset returns in the United States and other developed economies. The paper concludes by discussing factors such as international capital flows and forward-looking behavior on the part of market participants that could weaken the relationship between age structure and asset returns in a single nation.

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The Baby Boom generation, those born in roughly the two decades following World War II, has had and will continue to have important effects on the U.S. economy. The rising number of middle-aged workers today, and the relatively small number of children and younger workers, is often identified as an important contributing factor in the current low rate of aggregate unemployment, and in the associated rise of productivity growth (see Shimer (1998)). The prospective aging of the Baby Boomers will substantially increase the number of Social Security and Medicare recipients in the years following 2010. The difficulty of accommodating the growth in benefit flows without substantial "pre-funding" has led to current discussions of both Medicare and Social Security reform.

In financial markets, the portfolio behavior of the Baby Boom cohort has also been cited as a factor contributing to recent financial market movements. The entry of the Baby Boom cohort into its "peak saving years," and the associated increase in the demand for financial assets, is often cited in popular explanations of the rise in stock market values during the 1990s. Examples include Passell (1996) and Moon et al. (1998). In the late 1980s, Mankiw and Weil (1989) argued analogously that an increase in the share of the population in the key homebuying years of the late twenties and thirties was a key explanatory factor in the rise of real house prices during the late 1970s and early 1980s.

Assertions that middle-aged Baby Boomers have bid up prices of stocks and other real assets are often accompanied by predictions that when Boomers reach retirement age, their concerted decision to sell assets will result in declining asset values. Siegel (1998) summarizes this argument when he writes that "The words "Sell? Sell to whom?" might haunt the baby boomers in the next century. Who are the buyers of the trillions of dollars of boomer assets? The [baby boomer generation] … threatens to drown in financial assets. The consequences could be disastrous not only for the boomers' retirement but also for the economic health of the entire population.(p. 41)" Schieber and Shoven (1994) develop the same argument in their analysis of the link between demographic structure and the pattern of inflows and outflows from defined benefit pension plans. They note that the magnitude of any such effect is uncertain, depending on a host of factors including the degree of international capital market integration. They nevertheless suggest that "when the pension system begins to be a net seller [of assets] ... in the third decade of the next century ... this could depress asset prices, particularly since the demographic structure of the United States does not differ that greatly from Japan and Europe ... what we think may happen is high real interest rates, which could depress the prices of stocks, bonds, land, and real estate.(p.25)"

While the potential link between demographic structure and asset returns is widely discussed, there has been little systematic study of the historical relationship between these variables. This paper presents new empirical evidence on this issue. It focuses on the returns on Treasury bills, long-term corporate bonds, and corporate stock over the last seventy years. The analysis is designed to address a simple question: do average asset returns vary with changes in demographic structure? The empirical analysis pays particular attention to the robustness of these relationships, and to the wide range of alternative demographic variables that are available to the data analyst.

The paper is divided into five sections. The first develops a stylized model indicating how demographic changes can affect rates of return on various assets, and it summarizes previous research on demographic structure and asset returns. It includes both a discussion of stock markets and the market for owner-occupied housing. The second section describes the age structure of asset holdings in the current U.S. economy. It also presents survey-based information on the relationship between age and risk tolerance. Section three presents summary information on the historical correlation between various demographic variables and returns on bills, bonds, and stocks. The results suggest little if any relationship between demographic structure and asset returns. Section four reports corroborative evidence from Canada and the United Kingdom; in neither case does the post-war return experience suggest a strong effect of age structure on asset returns. The final section concludes with a discussion of various factors that may explain the apparently weak relationship between age structure and return patterns.

1. Demography and Asset Prices: Theoretical Framework and Previous Empirical Research

This second explores the effect of changing age structure on asset demands in a stylized economy. It then describes the empirical literature that has explored the impact of age structure on the realized returns on various assets.

1.1 Age Structure and Equilibrium Returns

To formalize the effect of changing asset demand on asset returns, it is helpful to consider a closed economy in which households live for three periods. Bohn (1998) carries out a related exercise in a two-period overlapping generations economy. In my setting, the young (y) and middle-aged (m) each supply one unit of labor to the market, while the old (o) do not work. The three age groups have fixed demands for financial assets given by S_y, S_m, and S_o, and the number of persons in each age group is given by N_y, N_m, and N_o, respectively. The total demand for capital in this economy is given by

(1) $K^d = N_y*S_y + N_m*S_m + N_o*S_o$.

The production sector is described by a constant-returns production function, so the rate of return to capital is a function of the capital labor ratio:

(2) $r = f'(K/N)$.

In this case $N = N_y + N_m$, the total amount of labor supplied to the economy, and $K = K^d$.

In this simple setting we can consider the effect of various demographic changes. First consider a population shift from the young to the middle-aged group, with $dN_y = - dN_m$. Such a shift does not affect the labor force, so the only effect on the rate of return is through the demand for capital:

(3) $dr = f''(K/N)*[(S_m - S_y)/N]*dN_m$.

Since $f'' < 0$, provided $S_m > S_y$, so that middle-aged households hold more financial assets than young households, this demographic shift would reduce the equilibrium return on capital.

A second demographic shock that we can consider involves a shift from middle-aged to older workers, again with a fixed total population. In this case $dN_m = -dN_o$. Because older workers are not in the labor force, a rise in the elderly fraction of the population has two effects: it alters the per capita demand for financial assets, and it also changes the size of the labor force. This implies that

(4) $dr = f''(K/N)*\{[(S_o - S_m)/N] + K/N^2\}*dN_o$.

If old households and middle-aged households hold the same levels of financial assets ($S_m = S_o$), then a population shift from the middle-aged to the older group unambiguously reduces the return to capital through its effect on the capital-labor ratio. If older households demand more financial assets than their middle-aged counterparts, this effect is reinforced. In the case when older households hold less financial assets than middle-aged households, however, the effect of the age shift on returns is ambiguous, because the age shift reduces both capital and labor in the economy. The resulting change in asset returns will depend on the empirical magnitude of these two effects.

The simple model sketched above does not allow shifts in returns to alter households' age-specific wealth holdings. It also assumes that all of the capital used in the stylized economy must be held in the portfolios of the households who live in that economy, and that changes in real wages that flow from changes in the capital-labor ratio do not affect the age-specific demand for assets. Allowing for such effects would complicate the analysis, and in some cases these effects could substantially alter the central findings.

First, consider the possibility that desired asset holdings are sensitive to rates of return: this would involve replacing S_y with $S_y(r)$, with similar changes for other age groups. If the demand for assets was very elastic with respect to the interest rate, then small changes in asset returns would lead to large adjustments in the capital stock, and there would be a small change in the equilibrium return as a result of demographic shifts. The current empirical literature on the aggregate interest elasticity of saving suggests relatively small effects, but there is relatively little information on how changes in prospective returns alter the age-specific saving rates of different households.

Second, consider how the foregoing analysis would be modified if the country in question was part of an integrated world capital market. In a "small open economy" the world interest rate would determine returns so shifts in the demand for financial assets that resulted from demographic change would affect the amount of capital owned by the country's residents, but not the capital-labor ratio used in production. The rate of return would not depend on the demographic mix within the nation.

The degree to which world capital markets are integrated remains an open question. While there are vast cross-border financial flows in fixed income markets, there is still a substantial "home bias" in equity ownership. French and Poterba (1991) present evidence showing that more than ninety percent of the equity assets of investors in the United States and Japan are held in their domestic equity markets. Feldstein and Horioka (1980), Frankel (1991), and Taylor (1996) document substantial correlation between national saving and national investment rates. These relationships make the effect of a change in a country's domestic saving rate and desired asset holdings on the equilibrium return on its capital stock an open issue. The ambiguity concerning the appropriate framework in which to consider shifts in asset demand in part motivates the empirical analysis of demographic structure and asset returns that follows.

A final difficulty with this simple model is that it does not allow for a forward-looking asset price of capital goods, in part because it does not model the durability of capital. If capital goods lasted for longer than one period, then a well-functioning asset market would price these capital goods so that their current market price would equal the expected present discounted value of future earnings. Because demographic shifts between young, middle-aged, and old workers are predictable as soon as the size of a birth cohort is revealed, there would be no adjustment of asset prices as large cohorts aged. Rather, the adjustment of asset prices would take place as soon as the size of this group's birth cohort became public information. Such an analysis suggests that in the case of the Baby Boom cohort, the news about the future pattern of asset prices was revealed when the Baby Boom was born, and not in the 1990s, when the older members of the cohort turned 50.

1.2 Previous Empirical Literature on Equity Markets and Population Age Structure

A small but growing literature has explored the link between stock returns and population age structure. The first study, by Bakshi and Chen (1994), finds support for the "demography matters" hypothesis in post-World War II U.S. data. The authors include a variable measuring the average age of the U.S. population in a standard Euler equation that relates the growth rate of consumption to stock returns. They find that average age increases the explanatory power of their Euler equation, but their method of estimation makes it difficult to interpret the effect of demographic change on asset prices. The fact that age structure improves the fit of an Euler equation could simply reflect other failures of the Euler equation, rather than the substantive importance of demographic factors. In addition, it is not clear why average age in the population, as opposed to other measures of demographic structure that might better capture the lifetime profile of asset accumulation, should be the focal explanatory variable. Poterba (1997) reports that other indicators of population age structure have much weaker effects in Euler equation models.

A second empirical study on asset returns and demographic structure, by Erb, Harvey, and Viskanta (1997), focuses on cross-national data for the period 1970-1995. The authors present evidence for the United States suggesting that there is a positive correlation between the fraction of the population between the ages of 25 and 45 and real stock returns, and also between the fraction 65+ and real stock returns. They find a negative relationship between the population share 45-65 and stock returns for their data sample. They also show that there is a positive relationship in both developed and developing countries between stock returns and the change in the average age of a country's inhabitants. This pattern emerges both in cross-sectional data, and in an analysis of time-series cross-section data. While these results suggest a possible link between demography and asset returns, since the increase in average age could proxy for changes in underlying economic conditions that reduce morbidity and mortality, or for other changes within a country, it is not clear whether this relationship can be viewed as causal.

A third study that presents related information, for only the U.S. stock market, is Macunovich (1997). This study presents regression equations that "explain" postwar movements in the real return on the Dow Jones Industrial Average using nearly a dozen variables on population age structure. The explanatory power of these regressions is substantial. As some of the results presented below suggest, however, these findings may be due to the presence of many different trend variables in the regression model. This leads to effective "overfitting" of the stock return time series, and to out-of-sample predictions that are sensitive to small changes in specification.

A final, unpublished, study that provides important evidence on asset returns and population age structure is Bergantino (1998). This study develops estimates of age-specific asset demands, and then uses these demands along with changing demographic structure to construct estimates of time-varying demand for financial assets. The findings suggest a clear relationship between the level of age-specific asset demand and the level of stock prices, and between the difference in asset prices and differences in "demographic demand" over multi-year horizons.

There are three difficulties with this empirical strategy. First, both the level of stock prices and the level of "demographic demand" are strongly trending variables. A first-order autoregression fit to annual data on the level of demographic-predicted equity demand has an estimated coefficient of 0.9725 (0.0079) for the 1926-1997 sample period. A similar first order autoregression on the level of real stock prices has a coefficient of 1.179 (0.023) for the 1926-1997 period. This suggests that both of these variables are integrated processes, and work beginning with Granger and Newbold (1974) has shown the dangers of "spurious regressions" between two integrated processes. At a minimum, this suggests that the apparent correlation between these variables may be less statistically significant than conventional tests would suggest.

The second difficulty with this approach is that age-specific asset demands in a cross section do not necessarily indicate how assets of a given cohort will vary as that cohort ages. When different birth cohorts experience different economic conditions over their lifetimes, or have different "tastes" for holding assets such as corporate stock, it can be inappropriate to use the current age-specific patterns of asset ownership for today's older cohorts to model the future behavior of today's younger cohorts. The next section addresses this problem and tries to resolve it using repeated cross-sections of data on household asset ownership.

The final difficulty with this approach is that use of annual data, or even multi-year differenced data, may provide an illusion of more degrees of freedom than actually apply to the problem at hand. There is one Baby Boom shock in U.S. demographic history, at least during the period when there have been well-developed, broad-based financial markets for securities such as corporate stock. As the Baby Boom cohort has approached age 50, real stock market wealth has risen rapidly. This is consistent with some variants of the demographic demand hypothesis. However, it is important to recognize that the postwar years represent essentially "one observation" on how demographic shocks affect asset returns.

1.3 Age Structure and Housing Markets: Another Asset Price Effect

The potential link between population age structure and real house values, first discussed systematically by Mankiw and Weil (1989), has attracted greater attention than the link between stock prices and population age structure. The literature following this initial study, including Engelhardt and Poterba (1991) and Hendershott (1991), cast doubt on the robustness of Mankiw and Weil's (1989) finding. The experience of the last decade also calls the relationship into question. Mankiw and Weil (1989) suggested that as the number of new homebuyers declined in the 1990s and subsequent years, real house prices might decline by as much as 47 percent by 2005. In fact, real house prices have remained roughly constant during the years since 1990. While one could point to other factors that may have contributed to this outcome, such as the buoyant U.S. economy, the basic pattern illustrates the difficulty of making long-term asset price projections based on demographic trends.

The case for a link between demographics and house values is, if anything, stronger than that for a link between demographics and the prices of stocks and bonds. One key feature of owner-occupied housing is that the asset holder must live in the same physical place as the asset. Thus a decline in the number of prospective homeowners in one location, whether a community or a nation, might lead to a reduction in the demand for housing assets in that location. This need not occur for financial assets, which can be traded across borders. This suggests that in considering how demographic developments may affect financial asset prices, it may be important to consider demographic changes on a multi-national scale.

2. Age Patterns in Asset Ownership

Behind all discussions of how demographic changes may affect asset markets, there is an assumption that there are pronounced age patterns in the ownership of financial assets. This could occur through differences in the direct ownership of financial assets, or through differences in the ownership of assets through pension plans and related retirement saving accounts. This section presents summary information on age patterns in direct household asset ownership. It does not consider assets held in defined benefit pension funds, which have received particular attention in Schieber and Shoven (1994).

2.1 Age-Asset Profiles in the 1995 Survey of Consumer Finances

The most comprehensive information on asset ownership in the United States is provided by the Survey of Consumer Finances (SCF), which is conducted by the Federal Reserve Board. The first "modern" SCF was conducted in 1983, and the survey has been carried out every three years since then. The most recent survey was carried out in 1998, but the most recent survey for which data are publicly available was carried out in 1995. Kennickell, Starr-McLuer, and Sunden (1997) provide a detailed description of the SCF, along with summary tabulations from the most recent survey.

The Survey of Consumer Finances can be used to measure average levels of asset holdings for individuals in different age groups. The basic unit of observation in the survey is the household, and most households include several adult members. To construct age-specific asset profiles, I have allocated half of the assets held by married couples to each member of the couple. Thus, if a married couple in which the husband is 62 and the wife is 57 holds $250,000 in financial assets, this will translate into $125,000 held by a 62-year-old, and $125,000 held by a 57-year-old.

There are two ways to describe the relationship between age and asset ownership. The first focuses on the current cross-section of individuals, and describes the average asset holdings of individuals of different ages at a point in time. The second tracks the evolution of asset holdings over an individual's lifetime. This requires data on asset holdings by the same individuals, or representative samples of individuals, at different points in time. The second approach is preferable, because it recognizes that different birth cohorts may hold different levels of assets throughout their lifetimes. For example, individuals who lived through the Great Depression may have lower levels of lifetime earnings, and correspondingly lower levels of net worth at all ages, than individuals who were born in more recent years. Comparing the age-specific asset holdings of different age groups at a given point in time may therefore provide an unreliable guide to the change in asset holdings that will take place as current cohorts age.

Table 1 reports average holdings of common stock, net financial assets, and individual net worth, by net worth, for individuals in different five-year age groups in 1995. The table shows that there are important age-related differences in the levels of assets and in net worth. The table focuses on mean holdings, which are much higher than median holdings at all ages. Average holdings of net financial assets rise with an individual's age for those between their early 30s and those in their early 60s. There is a decline in the rate of increase in financial asset holdings for individuals at older ages, but there is no evident decline in net financial assets when we compare those above age 75 with those in somewhat younger age groups.

A similar pattern emerges with respect to both corporate stock and net worth. Older individuals exhibit larger asset holdings than younger ones, but there only a limited downturn in average asset holdings at older ages. There is some downturn in holdings of corporate stock, where the age-specific ownership peaks between the ages of 55 and 59 at $38,319, and declines by nearly $10,000 for those in the next two age categories. (The imprecision of the age-specific asset holdings makes it difficult, however, to reject the null hypothesis that stock holding is constant at ages above 55.) Net worth, which includes financial assets as well as holdings of owner-occupied real estate, other real property, equity in unincorporated businesses, and assets held through defined contribution pension plans, rises up to age 55, and then plateaus for the remainder of an individual's lifetime.

As noted above, it is difficult to interpret a cross-sectional age-asset profile like that in Table 1 because of the confounding effects of age and cohort effects. If older cohorts have lower lifetime earnings than younger cohorts, and if the accumulation of financial assets is correlated with lifetime earnings, then we could observe lower asset holdings at older ages even if households did not draw down assets in their old age. Alternatively, if older households had higher lifetime earnings on average than their younger counterparts, it would be possible to observe a rising age-asset profile at all ages, even if older households did reduce their asset holdings as they aged.

To explore the pure "age effect" on asset accumulation, I follow the approach employed by Poterba and Samwick (1997) in modeling household wealth data. I use repeated cross-sections of the Survey of Consumer Finances from 1983, 1986, 1989, 1992, and 1995 to estimate age profiles of asset ownership allowing for different lifetime asset levels for different birth cohorts. The empirical specification models $ASSETS_{it}$, the level of assets (or some specific type of asset) held by group I in period t as:

(5) $$ASSETS_{it} = \Sigma \beta_j * AGE_{ijt} + \Sigma \alpha_k * COHORT_{ik} + \varepsilon_{it}$$

where β_j denotes the "pure" age effect on ownership of a given asset category, and α_k denotes a birth-cohort specific intercept term that captures the level of assets held by different birth cohorts. The β_j coefficients can be interpreted as the best predictor of how movements from one age group to another will change the asset holdings of different groups.

Table 2 presents the estimates of the age effects from (5) for the three asset categories considered in Table 1. The patterns are similar, and they can be interpreted as lifecycle trajectories of asset holding. The results provide clear evidence that holdings of common stock and total financial assets increase as individuals age, but once again the decline in assets as individuals enter old age is much less pronounced than the increase in asset holdings during middle age. For equities, for example, real holdings of common stock peak between the ages of 55 and 59, at $32,515. They decline to $28,219 for those between the ages of 70 and 74, and further, to $24,722, for those over the age of 75. For net financial assets there is virtually no decline in old age, with peak holdings between the ages of 70 and 74, and for net worth, the peak occurs between 65 and 69 with a notable decline by age 75+. The finding of a limited decline in financial asset holdings as individuals age is important, since it suggests that the rush to sell financial assets that underlies predictions of "market meltdown" in 2020 or 2030 may be less pronounced than some analysts have suspected. The results in both Tables 1 and 2 suggest that there are substantial increases in asset holdings as households move through their 30s and 40s, which suggests that the aging of the Baby Boom cohort to date may have had an impact on the demand for financial assets.

One issue about the data in Tables 1 and 2 that bears note is the fact that these tables report individual, not household, asset holdings. For most of the lifecycle, dividing household assets equally across adult members of the household seems like the natural way to generate a reliable age profile of asset holdings. For individuals in their 70s and 80s, however, mortality can have an important effect on the measured trajectory of asset holding. This can occur in several ways. First, there is clear evidence (see Rogot et al. (1992)) that individuals in high net worth households have lower mortality rates than those with lower net worth or lower lifetime income. This suggests that the individuals who survive to advanced ages may be a selected group, biased toward a higher net worth part of the population. Second, when one member of a married couple dies, the couple's assets will typically flow to the surviving spouse. This can raise the net worth of the survivor relative to what it would have been when this individual's spouse was still alive. Finally, it is not clear how one should model the effect of death of a surviving spouse, and bequest of assets to younger heirs, on the demand for financial assets. There is relatively little information available on whether those who receive inheritances save their funds, and thereby continue to hold assets, or use the funds to finance higher consumption.

The analysis of financial asset holdings in Tables 1 and 2 ignores assets that are accumulated through defined benefit pension funds. Schieber and Shoven's (1994) analysis of population aging and asset demand emphasizes the almost mechanical accumulation, and then decumulation, of assets that occurs as individuals age in a defined benefit pension regime. In most cases, the value of the assets that are accumulated in defined benefit plans peak when an individual retires. As benefits are paid out, the actuarial present value of the remaining payouts declines, and the assets needed to provide these benefits decline. This implies that the total assets in a defined benefit pension system will vary substantially as the participant population ages. This implies that there is a substantial force of accumulation, and then decumulation, as a large birth cohort moves through its lifecycle. The open question concerns how such an age transition affects financial asset values.

2.2 Risk Tolerance and Age Structure

One particular aspect of the aging process that emerges in some previous discussions of demography and asset values concerns individual risk tolerance. Bakshi and Chen (1994) justify their inclusion of age variables in Euler equations relating consumption growth on the grounds that older individuals are less risk tolerant than younger individuals. They reason that changes in the age structure of the population should therefore affect the equilibrium risk-return tradeoff that is reflected in market prices.

The Survey of Consumer Finances provides some direct evidence on age patterns in risk aversion. Respondents are asked to describe their views about risk and return. In particular they are asked whether they are prepared to accept "substantial risk in pursuit of substantially above-average returns," "above average risk in return for above-average returns," "average risk for average returns," or virtually no risk in pursuit of higher investment returns. Table 3 shows the resulting breakdown of responses, tabulated by the age of the head of the household responding to the SCF. The table is divided into two parts. The first shows the responses of the self-selected subset of individuals who hold corporate stock, while the second shows the responses for the entire population. Not surprisingly, the investors who hold some stocks are more prepared to take risk than are their non-equity-investing counterparts. This is particularly evident in the much higher fraction of the general population that indicates an unwillingness to take any risk in pursuit of higher returns.

The table shows that age is indeed related to risk tolerance. There is a substantial difference between the fraction of households headed by individuals who are younger than 65, and the fraction headed by individuals older than 65, in the willingness to take some risk in return for higher average returns. There are no clear patterns among younger individuals. These findings provide some support for the analysis that underlies the Bakshi and Chen (1994) study, and they provide a justification for further empirical analysis of the links between population age structure and asset returns. The data on risk aversion also suggest, however, that simple summary measures, such as the median age in the adult population, may not be the appropriate variable for analysis. Instead, these data suggest that the fraction of the population over the age of 65 may be the more natural variable to consider.

2.3 Changing Demographic Patterns, 1950-2050

The foregoing analysis provides a rationale for considering the link between demographic structure and asset returns. Because fertility rates were high in the years immediately following World War II, and then declined in the 1960s, the "Baby Boom" cohort is substantially larger than the cohorts that preceded or follow it. This implies that the aging of the Baby Boomers has a substantial effect on the age structure of the United States population.

Table 4 presents summary statistics on various measures of the demographic structure of the U.S. population every ten years between 1920 and 2050. The values for years beginning in 2000 are based on Census projections. The table shows that by the year 2000, the median age of the U.S. population will have increased by more than five years since 1950. The median age is projected to increase by more than two years between 2000 and 2050. Current projections suggest that median age in 2000 will be more than ten years greater than median age in 1900. The two periods of most rapid increase in median age during the last century were the 1920-1940 period, and the post-1960 period. The average age of the adult population, shown in the second column, has changed by less than the median age. Between 1930 and 1960, the average adult age rose by 4.2 years, however. The average adult age shows both increases and decreases during the postwar period.

The fraction of the population in the key "asset accumulating years," 40-64, has increased by several percentage points since 1970. It will decline by nearly three percentage points between 2000 and 2050. This measure exhibits substantial long-term and short-term variation. In 1900, this demographic summary statistic was 19.4 percent; in 1995 it was 27.5 percent. During the post-war period, however, this fraction fluctuates from 27 percent in 1950, to 24.7 percent in 1980, and then to 27.5 percent in 1995. The changes reflect the maturation of the Baby Boom and Baby Bust generations.

The table shows that there was a rapid change between 1950 and 2000 in the median age of the entire population, with a smaller change in the average age of those 20+. In the next 50 years, however, the most dramatic change will be in the average age of those 20+. Today, the population between the ages of 40 and 64 is 2.3 times as large as the population over the age of 65. By 2050, this ratio will have declined to 1.4. As a share of the adult population, those between the ages of 40 and 64 will account for 42.6 percent of the population in 2000, up from 36.1 percent in 1990. This fraction is not substantially higher than the value in 1970 (42.3 percent). Moreover, the recent change is comparable to (but in the opposite direction of) the decline in the share of the adult population in late middle age that occurred in the early 1970s as the Baby Boom cohort reached adulthood.

The demographic projections underscore the importance of potential links between asset returns and population age structure. If older individuals have less demand for financial assets than their middle-aged counterparts, then an age shift like the one that is projected to take place could affect the aggregate demand for financial assets and ultimately the prices of, and returns on, such assets.

2.4 Integrating Age-Specific Asset Demands and Changing Demographic Structure

The information on age-specific asset holdings suggests that asset demands rise when households age, but it does not suggest a downturn in asset holdings at the end of the lifecycle. To illustrate the impact of population aging on the demand for financial assets, Table 5 presents summary statistics on per capita asset demands every ten years between 1950 and 2050. The calculations that underlie the entries in this table are based on information from Table 1 and the Census population projections. Projected asset holdings in each year are defined by:

(6) $$(\text{PROJECTED ASSETS})_t = \Sigma \text{ ASSETS}_i * N_{it}$$

where ASSETS_i denotes the age-specific asset holdings shown in Table 1, and N_{it} denotes the Census projection (or actual value) for the number of individuals of age I in year t.

Table 5 shows that projected asset demand for common stock and for financial assets more generally, as well as projected household net worth, rises in the four decades between 1980 and 2020. The table presents data using the cohort approach to estimating age profiles for asset accumulation, as well as the more traditional "cross-sectional" approach discussed above. There was a small projected decline in both common stock holdings, and in net worth, in the two decades preceding 1980s; this reflected the rising number of young households in the economy. (Young households have relatively low levels of asset holdings). The table also shows an expansion of assets per capita over the next three decades. The growth rate of assets per capita declines after 2030, but there is no absolute decline in per capita holdings of financial assets or corporate stock after that date.

The findings in Table 5, and the data that they are based on in Tables 1 and 2, suggest that the textbook model of a "lifecycle consumer" accumulating assets while working, and then drawing these assets down in retirement, does not provide an accurate description of average asset accumulation profiles. This finding is consistent with a number of other studies on saving behavior; see Hurd (1990) for a survey and Poterba (1994) for a discussion of international evidence on this issue. Even if most households draw down their assets in retirement, the average value of financial assets may not decline at older ages. This is because, as Poterba and Samwick (1995) report, the ownership of financial assets is highly concentrated. The wealthiest ten percent of households hold roughly seventy percent of household financial assets excluding corporate stock, and nearly ninety percent of corporate stock. Thus the asset decumulation behavior of a small set of households is likely to be the primary determinant of age-specific asset balances.

3. Demographic Variables and Population Age Structure

The foregoing analysis suggests that it is difficult to choose a single measure of demographic structure as "the variable" that should affect asset returns. Rather than trying to make an arbitrary choice among such variables, this section presents empirical results that exploit a range of different potential measures of demographic structure. The section is divided into three sub-sections. The first presents bivariate regression results relating asset returns to several summary measures of population structure, such as the median age variable that was used by Bakshi and Chen (1994). The next sub-section uses information on the "projected assets" defined at the end of the last section, and relates changes in this demand variable to asset returns. Finally, the empirical results in the last sub-section are based on a "nonparametric" approach in which several different variables are simultaneously used to proxy for demographic structure. The variables I use are the logarithms of the shares of the population in various ten-year age intervals. While the collinearity between shares makes it difficult to focus on any individual coefficient in the resulting regression specification, it is possible to test the joint significance of the demographic variables in explaining asset returns, and to make projections based on these models.

3.1 Age Structure and Asset Returns: Summary Evidence

In its simplest form, the hypothesis that population age structure and the associated age-induced demand for financial assets affects the equilibrium level of asset returns can be tested by computing correlations between asset returns and the various demographic measures in the last section. This section presents such evidence for three different assets: Treasury bills, long-term government bonds, and large corporate stocks (as measured by the return on the S&P index). My analysis focuses on the period 1926-1997, when Ibbotson Associates (1998) provides a reliable and comparable data series on returns. For all three asset classes I also consider the correlations in the post-war period, 1947-1997, and 1926-1975 sample. Considering several different asset categories provides information on returns on both relatively low-volatility assets (Treasury bills) and more risky assets. Considering several different assets also allows for the possibility that age-related patterns in the demand for particular assets (such as equities) lead to more pronounced demographic effects for some assets than for others. The rationale for considering different sample periods is to develop some evidence on the robustness of the findings.

Table 6 presents the estimated β_j coefficients from regression models of the form:

(7) $R_{i,t} = \alpha + \beta_j*(\text{DEMOGRAPHIC VARIABLE})_{j,t} + \varepsilon_{i,t}$

where $R_{i,t}$ denotes the real return on asset i in year t, and $(\text{DEMOGRAPHIC VARIABLE})_{j,t}$ denotes the value of one of the demographic variables defined in the last section.

The results for the long sample period provide at best limited support for a link between asset returns and demographic structure, and only in the markets for fixed income securities. Of the fifteen reported coefficients (five demographic measures and three return variables), only four are statistically significant at conventional levels. These are the coefficients on the fraction of the population between the ages of 40 and 64, in equations for the yields on Treasury bills or the total return on government bonds, with this population group scaled either by the total population or the adult population. In each case the estimated coefficients are negative, suggesting that an increase in the fraction of the population in the key asset-accumulating years reduces required returns and thereby lowers observed returns. The corresponding coefficient on corporate stock returns is positive, although the standard error is too large to permit precise inferences.

The estimated effects of these variables are substantively significant as well as statistically significant. The percentage of the population between the ages of 40 and 64 will rise by nearly .05 (five percentage points) between 1975 and 2000. The point estimate of -1.79 on real bill yields and -1.93 on real bond yields imply changes in asset returns of between 700 and 1000 basis points as a result of demographic change. The magnitude of these projections casts doubt on the empirical relationship between demographic structure and asset returns. When the projections suggest extremely large changes from future movements in demographic structure, it may indicate that the estimated coefficient is capturing other omitted factors that are correlated with both demographic structure and historical returns.

These findings do not appear robust to changes in the sample period of estimation, however. When the sample begins in 1947, the point estimates of the effect of the 40-64 population share on bill and bond returns are roughly one third of the estimates for the longer sample period. For the 1926-1975 sample period, the estimated effects are larger than those for the full sample.

In addition to the results for the percent of the population 40-64, in the postwar period there is also a negative effect of the ratio of the population share 40-64, divided by the share 65+, on bill and bond returns. This effect is specific to the postwar sample, however, and both coefficients are of the opposite sign, and statistically significant or nearly so, for the 1926-1975 period.

Three conclusions emerge from Table 6. First, most measures of population age structure do not appear to be correlated with asset returns on bonds, bills, or equities. Second, the results are not robust across sub-sample periods, and the estimated coefficients vary significantly between the post-war and interwar periods. Finally, there is essentially no evidence of a link between demographic structure and equity markets, although that is the market in which the recent shift in age structure is most often advanced as an explanation for observed returns.

The conceptual model that underlies the equations that are presented in Table 6 is one in which the required return on assets is a function of the age structure and associated asset demand in the population. It is consistent with the simple theoretical framework presented earlier. A second conceptual framework, however, and one that is difficult to ground in rational expectations models, argues that the change in the population share in key asset-buying age categories is the key predictor of observed returns. This approach ignores the possibility that changes in demography are predictable, and that the change in a given year or several year period conveys little "news" to asset markets.

The explanatory power of a "demographic change" specification is nevertheless an open empirical question. Table 7 presents results that address this issue. In this table annual returns are related to annual changes in the demographic variables. The dependent variables in these specifications are the same as those in Table 6. The independent variables in Table 7 are simply the annual differences of the independent variables that were studied in Table 6. Once again, the variable involving the percentage of the population in the age 40-64 category is the strongest explanatory variable. The change in this population share has a statistically significant effect in explaining both bond and bill yields, but the coefficient is now the opposite of that in the level equations. A within-year increase in the share of the population between the ages of 40 and 64 is positively correlated with the T-bill yield and with the return on government bonds. The estimated coefficients are relatively stable across different subsamples, and imply a substantively significant effect on asset returns. A one half of one percentage point increase in the 40-64 population share (which is a very large change in the independent variable) would correspond to a 234 basis point increase in the T-bill yield, and to a nearly 700 basis point change in the return on long-term government bonds. This may seem implausibly large to many readers. There is also some evidence for the post-war period of a positive correlation between the change in the share of the age 20+ population that is between the ages of 40 and 64, and the return on common stock. The inconsistency between the results in Tables 6 and 7 also casts doubt on the general robustness of any links between demographic structure and asset returns.

Table 8 presents results that are based on the full-sample (1926-1997) specifications in Tables 6 and 7. The specifications in Table 8 are not estimated on annual data, as the earlier equations were, but rather are estimated using data on five-year non-overlapping "interval observations." The rationale for exploring such a specification is that the relationship between demographic factors and returns may not be driven by high-frequency variation, but rather by low-frequency movements. Studying the relationship between five-year average returns and five-year averages of, or five year changes in, the demographic variables places greater weight on low-frequency movements than the specifications in Tables 6 and 7.

The results are broadly consistent with those in the previous two tables. For most of the demographic variables, such as median age and the average age of those over 19, the estimated coefficients are statistically indistinguishable from zero. There is some evidence that the population between the ages of 40 and 64 is correlated with returns, with effects in the directions found above: negative for the level of population share, positive for changes. These findings are generally supportive of the use of annual data for the regression models.

To summarize the information from Tables 6 and 7, and to illustrate the potential effects of changes in demographic structure in the next half century, Table 9 reports the fitted values (within-sample predictions) as well as out-of-sample predictions for asset returns. These fitted and predicted values are calculated using the estimated coefficients in Tables 6 and 7 along with data on demographic projections from the Census Bureau, as reported in Table 4. The results suggest some rather strange predictions on the basis of the models that exhibited statistically significant coefficients in the earlier tables.

Consider, for example, the results in the middle column, which reports the predictions from equations in which the explanatory variable is the level or change in the percentage of the population between the ages of 40 and 64. In the level specification, the predicted yield on T-bills falls to –12 percent in 2010, and it is negative throughout the 2010-2050 period. The change specification yields more plausible results. In this case the predicted real yield on T-bills is predicted to fall to seventy basis points in 2010, and effectively to zero after 2030. For long-term bond returns, the level specification also yields sharply negative predicted returns in the early part of the next century, along with more modestly negative returns for most of the century. These extreme predictions cast doubt on the level specification as a useful device for exploring the links between asset returns and demographic structure.

For equity returns, the various demographic variables generate a range of different predictions regarding prospective returns. The estimates in the upper panel of Table 9, which are based on level specifications for the demographic variables, suggest rising real equity returns in the case when median age is the explanatory variable, but show some decline in equity returns for most of the other demographic variables. The large standard errors of prediction for all of these estimates, however, underscore the difficulty of drawing any firm conclusions on the basis of these empirical models. The results in the lower panel, which are based on empirical models in which the change in the demographic variable is the independent variable, are more likely to project declines than increases in the real equity return between 1990 and 2030, but once again, the standard errors are large. With out-of-sample standard errors of prediction on the order of .20, it is difficult to draw any conclusion from projected differences of .02 or .03 in real equity returns.

3.2 "Demographic Projected Asset Demand" and Returns

The analysis in the last sub-section imposed relatively little structure on the relationship between demographic change and asset returns. It adopted an ad hoc approach to selecting potential explanatory variables. The discussion of age-specific asset demands in the Survey of Consumer Finances, however, provides a more structured approach to investigating how asset returns are affected by demographic change. It is possible to relate asset returns to the level of, or the change in, the "projected asset demand" variable that was presented in Table 5. This variable uses evidence on the age-specific evolution of asset holdings, along with information on the age structure of the population in various years, to form a "predicted" measure of asset demand. It is therefore a way of formalizing the possible links between changes in the population of various ages and the desire to hold financial assets.

Table 10 reports the result of estimating regression models in which the returns on bills, bonds, and stocks are related to the level of the projected asset demand variable, or the difference in this variable. The table reports a number of different specifications, corresponding to different sample periods and including some results from the five year average or difference specification.

The table also shows the findings from three different measures of projected asset demand. The first is based on age-specific patterns of corporate stock ownership, the second on age-specific ownership of net financial assets, and the third on age-specific net worth. These variables correspond to the time series shown in Table 5. If required returns on all assets are set in well-functioning markets that generate the same risk-adjusted return across securities, then a broad-based measure of asset demand, such as that for household net worth, should be the best predictor of asset returns. If there is some segmentation across markets, however, the projected demand variable based on common stock may have more predictive power for equity returns, and net financial assets might be best at tracking fixed income returns.

The results in general suggest very limited linkage between any of the projected demand variables and the realized patterns of asset returns. This is particularly true for the full sample estimates. None of the estimated coefficients relating returns to the level or to the change in projected asset demand, using either the cross-sectional or the cohort approaches to generating projected asset demand, are statistically significant at standard significance levels. There is some, limited evidence of a positive relationship between the change in projected asset demand and the level of asset returns, particularly for common stock returns, in the specifications that employ five-year non-overlapping changes in asset demand. When the cohort estimates of asset demands at different ages are used to create the projected asset demand variable, there is a significant and positive association between the changes in the asset demand variable calculated using equity holdings, net financial assets, and net worth, and the level of equity returns. There is also some evidence for a correlation between equity returns and changes in these asset demand variables in the post-1947 sample period.

In spite of these correlations, however, the general pattern of results in Table 10 confirms the earlier conclusion that there is at best a weak, and not particularly robust, relationship between demographic structure and asset returns in the post-1926 U.S. experience.

3.3 Further Evidence Using Detailed Information on Age Structure

While the last subsection moved toward a more structured relationship between demographic structure and asset returns, some might argue that none of the empirical work presented above allows enough flexibility to uncover the patterns that link asset returns to demographic variables. In particular, Macunovich (1997) reports results that appear to use demographic variables to track movements in the real value of the stock market throughout the postwar period, and her approach is essentially a "nonparametric" one in which various age groups' shares of the aggregate population are used as independent variables. To explore the power of such equations, this subsection uses such variables to explain the real returns on bills, bonds, and stocks.

Table 11 reports results of regression models that include nine distinct demographic variables as explanatory variables. These are the logarithms of the shares of the population in nine different age groups: < 5, 5-14, 15-24, …, 65-74, and 75+. If a population composed of individuals in their 40s and 50s is associated with higher asset returns, then the coefficients on these variables should be positive. If a population with many individuals above the age of 65 is associated with asset decumulation, then the coefficients on these age share variables should be negative.

The results provide some evidence for the full sample period that a larger population in the 65-74 age group is associated with lower returns on T-bills, bonds, and corporate stocks. For bills and stocks, it is possible to reject the null hypothesis that the estimated coefficients are zero at standard statistical confidence levels. The coefficients for the population share 75+ are positive (but insignificantly different from zero) for two of the three asset classes, however, for the 1926-1997 period. The pattern for the 1947-1997 sample is the same as that for the longer sample, although the individual coefficient estimates are not significantly different from zero.

The results in Table 11 also suggest that including a detailed set of demographic variables can explain a substantial share of the variation in returns, at least for T-bills and for long term government bonds. The explanatory power of the regression equations differs substantially across assets, and the adjusted R^2 values are very low for equity returns. However, as with some of the earlier specifications, the plausibility of the models can be evaluated by studying the predicted values from these equations. Table 12 presents the long-term forecasts that emerge from the estimated equations in the upper panel of Table 11. The predictions are very strange, especially for corporate stock returns. The predicted return on stocks in 2030 is 126.8 percent per year, while the associated return on long-term bonds is –29 percent. These predictions are an important warning against the use of specifications like those in Table 11. When the regression model includes many different trending variables, there is a danger of obtaining a very good in-sample regression fit even though the specification does not accord with the conceptual model that motivates the equation. One warning sign of this situation is out-of-sample predictions that quickly become implausible. Thus, it does not appear that the high in-sample explanatory power of these models for T-bills or for government bond returns represents powerful evidence of a link between demographic factors and asset returns.

4. International Evidence: Age Structure and Asset Returns in Canada and the United Kingdom

One of the difficulties with analyzing demographic structure and asset returns in a single nation is that there are effectively very few observations on age structure change and financial markets. This is because demographic structure changes very slowly, and because there is substantial persistence in birth rates and mortality rates. One way to overcome this problem is to search for data on asset returns in several different markets, and to study the relationship between age structure and returns across nations. Relatively few nations have had liquid, developed equity markets for a long period, and investments in corporate stock play a minor role in household portfolios in all but a few nations. This raises questions about the evaluation of results from large cross-sectional studies such as Erb, Harvey, and Viskanta (1997). The patterns that emerge from studies of demographic change and asset returns in financial environments that are very different from that in the contemporary United States may not provide much guidance on the potential effects of demographic change on returns in the U.S. and similar markets.

Rather than exploring returns in a wide range of different markets, I have considered the time-series relationship between demographic change and asset returns in two well-developed financial markets: Canada and the United Kingdom. My analysis focuses on equity market returns for the period 1961-1997 in Canada, and 1961-1996 in the U.K. (The U.K. data sample is constrained by the limited availability of demographic data.) Data on equity market returns for these samples are computed from information provided by Morgan Stanley – Capital International. Returns are measured in local currency for both nations. Data on Treasury bill returns, on returns to holding long-term bonds, and on the Consumer Price Index in each country were drawn from the IMF Database. Returns on fixed-income instruments were available for the period since 1950, so the sample for Canada is 1950-1997, while that for the U.K. is 1950-1996. Demographic data were tabulated from various issues of the United Nations Demographic Yearbook, updated as necessary using data from the U.S. Census International Database, and the United Kingdom Annual Abstract of Statistics.

To avoid presenting the broad range of results that previous tables reported for the United States, I have concentrated my analysis on demographic variables that exhibited some link to asset returns in the U.S. data. My focus in the international analysis is on the relationship between the share of the adult population aged 40-64, or the change in this population share, on returns on bills, bonds, and stocks.

Table 13 presents the central findings from regressions including this demographic measure as an explanatory variable. For stock returns, the coefficients on both the level and the changes in this demographic variable are statistically insignificantly different from zero for both countries. The standard errors are particularly large for the specifications that involve differences of the demographic variable, so the confidence intervals would admit a wide range of possible coefficients. For bonds and bills, however, there is some evidence of a positive relationship between both the level of this population share variable, and its change, and returns. For Canada both the level and the difference have statistically significant coefficients, while for the U.K., only the difference specification shows a statistically significant effect. The results using the difference in this demographic variable are similar to those for the United States in the 1947-1997 period, reported in Table 7. The positive relationship between the level of this demographic share and the level of asset returns for Canada is different from the pattern observed in the United States.

I also estimated (but do not report) regression equations relating asset returns to other demographic variables like those considered above for the United States. (It was not possible to construct a "projected asset demand" variable for Canada or the United States, since that requires repeated cross-sectional surveys on household wealth holdings.) The results, like those in Table 13, were similar to those for the United States. Most of the demographic variables did not exhibit a statistically significant correlation with bill, bond, or stock returns. I have also estimated "nonparametric" models like those in Table 11. The predictions from these equations, like those from the equations for the United States, are frequently outside of the historical range of experience with asset returns. This calls into question the general reliability of these equations, just as the extreme predictions did in the United States case.

5. Conclusion and Future Directions

This paper explores the relationship between the age structure of the U.S. population, and the average return on various financial assets, during the last seventy years. There is little robust evidence suggesting a link between the age structure of the population, or the change in that age structure, and average asset returns. What correlations do emerge are stronger between Treasury bill returns, and long-term government bond returns, and demographic variables, than between stock returns and these explanatory variables. For most of the variables that I constructed to measure demographic structure, however, there was no statistically significant relationship between demographic factors and asset returns. This finding applies to a measure of age-structure induced variation in asset demands, based on information about the typical pattern of asset accumulation as individuals age, as well as to more "mechanical" measures of demographic variation such as the fraction of the population in various age groups.

One possible interpretation of the findings presented here is that even though changes in age structure do affect asset demand, and thereby equilibrium asset returns, these effects are simply too small to be detected amongst the other shocks to asset markets. The strong persistence of demographic structure from year to year also limits the effective variation in the key explanatory variables. One can argue that the U.S. has experienced one demographic shock in the post-war period, and that inferences based on a single observation are necessarily difficult!

The limited information in the historical data on demographic structure and asset returns makes it difficult to provide advice to those who would like to know how to forecast potential long-run rates of return on bonds, stocks, and bills over the next half century. This is made even more difficult because some of the key factors that may affect the future impact of demographic structure on asset returns are difficult to forecast. Perhaps the most important is the development of financial markets in currently "emerging markets," and the linkage between such asset markets and the markets in currently developed nations. Siegel (1998) succinctly presents the issue when he writes that "The developing world emerges as the answer to the age mismatch of the industrialized economies. If their progress continues, they will sell goods to the baby boomers and thereby acquire the buying power to purchase their assets. (page 41)" Changes in the structure of government retirement programs and health insurance arrangements could also have an important effect on prospective age-specific saving rates. If government provision of retirement income declines, this may stimulate saving among younger workers, thereby changing the current age-wealth accumulation profile.

One natural directions in which the current work could be extended concerns the treatment of defined benefit pension assets. The present paper's development of a "projected asset demand" variable included only the assets that individuals purchase directly or through defined contribution pension plans. It did not include accumulations on their behalf in defined benefit plans. While these plans have not grown as rapidly as defined contribution plans in recent years, they still represent an important component of the retirement income marketplace. The "mechanical" changes in the net accumulation profiles of these plans that Schieber and Shoven (1994) identified suggest that at least one source of asset demand will rise, and then decline, over the next few decades. The empirical evidence presented here, which relies on reduced form relationships between population age structure and returns, suggests that the accumulation of assets in defined benefit pension plans has not been large enough, historically, to leave a clear trail in measured asset returns. It would nevertheless be valuable to improve the "projected asset demand" methodology to include the age-specific accumulation of assets in defined benefit pension plans.

Another promising direction for further work is the explicit treatment of the complex interactions between demography and asset returns in an asset market with rational expectations. If investors recognize today that the Baby Boom generation's demand for financial assets over the next four decades might affect equilibrium required returns, this information should already be incorporated into the prices of financial claims. Quantifying such effects in a plausibly-calibrated model of asset market equilibrium represents an important, if longer-term, research objective. The goal of such research should be to provide evidence on both the long-run or "steady state" effects of changing fertility patterns on capital-labor ratios and therefore on average returns. It should also provide insight on the path that asset prices follow in a transition from one demographic steady state to another.

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Table 1: Age-Specific Asset Demands Estimated from 1995 Survey of Consumer Finances: Cross-Section Data

Age of Household Head	Common Stock Holdings	Net Financial Assets	Net Worth
15-19	$ 0	$ (1,897)	$ 10,144
20-24	384	(4,375)	7,635
25-29	3,073	(6,591)	19,798
30-34	4,666	(7,952)	30,666
35-39	7,438	(4,437)	53,767
40-44	14,593	5,532	90,606
45-49	21,762	20,831	131,932
50-54	29,965	41,119	169,574
55-59	38,319	51,425	186,505
60-64	29,416	53,548	178,648
65-69	29,219	77,442	189,068
70-74	31,367	72,306	190,729
75 & up	34,558	83,815	167,279
All Ages	18,272	38,350	106,399

Note: Estimates are based on 1995 Survey of Consumer Finances. Common stock holding includes assets held through defined contribution pension accounts. Net financial assets subtracts mortgage debt and other types of consumer and investment debt from gross financial assets. Net worth is the sum of net financial assets, the gross value of owner-occupied housing, and holdings of other assets such as investment real estate.

Table 2: Age-Specific Asset Demands Estimated from Combined Surveys of Consumer Finances, 1983-1995

Age of Household Head	Common Stock Holdings	Net Financial Assets	Net Worth
15-19	$ 0	$ 2285	$ 11042
20-24	470	2170	13656
25-29	1477	4477	25471
30-34	3391	9402	37706
35-39	5906	14325	60758
40-44	10795	20236	86808
45-49	18631	37122	123683
50-54	23913	57396	151981
55-59	32515	71884	177522
60-64	31004	80931	189134
65-69	30822	92262	201509
70-74	28219	92366	173796
75+	24722	92239	144316

Notes: Estimates are based on regression models that relate real holdings of various assets by age cohorts in different survey years to a set of cohort "intercepts" and indicator variables for various age groups.

Table 3: Risk Tolerance by Age Group, 1995 Survey of Consumer Finances

Age of Household Head	"Take Substantial Risk to Earn Substantial Reward"	"Take Above Average Risk for Above Average Reward"	"Take Average Risks for Average Returns"	"Not Willing toTake Any Financial Risks"
Population That Holds Stocks or Equity Mutual Funds				
< 25	3.9%	34.5%	41.9%	19.7%
25-34	9.8	34.2	45.5	10.6
35-44	5.6	26.4	54.2	13.8
45-54	4.8	24.8	58.6	11.8
55-64	1.7	22.2	62.1	14.0
65-74	4.1	12.8	56.7	26.4
75-84	3.2	7.0	33.2	56.6
> 85	0.0	12.4	33.1	54.5
TOTAL	5.0	23.2	52.7	19.1
Entire Population				
< 25	6.3%	14.0	39.8	39.9
25-34	4.3	20.3	38.4	37.0
35-44	4.5	17.0	42.5	36.0
45-54	3.8	14.5	42.0	39.8
55-64	2.2	10.7	38.1	49.0
65-74	2.0	5.9	29.1	62.9
75-84	1.2	3.1	23.5	72.1
> 85	0.0	5.0	14.8	80.3
TOTAL	3.5	13.6	37.3	45.6

Source: Author's tabulations using the 1995 Survey of Consumer Finances.

Table 4: Actual and Forecast Values for Indicators of Demographic Structure, 1950-2050

Year	Median Age	Average Age of Those 20+	Percent of Population 40-64	(Population 40-64)/ Population 65+	(Population 40-64)/ Population 20+
1920	25.3	40.3	22.2	4.8	0.375
1930	26.5	41.2	24.1	4.4	0.392
1940	29.1	42.2	26.5	3.9	0.404
1950	30.2	43.5	27.0	3.3	0.409
1960	29.4	45.3	26.5	2.9	0.431
1970	27.9	45.2	26.3	2.7	0.423
1980	30.0	44.5	24.7	2.2	0.362
1990	32.8	45.1	25.7	2.1	0.361
2000	35.7	46.6	30.4	2.4	0.426
2010	35.7	46.6	30.4	2.4	0.456
2020	37.6	49.2	30.5	1.8	0.416
2030	38.5	50.5	28.0	1.4	0.382
2040	38.6	51.0	27.9	1.4	0.381
2050	38.1	51.1	27.6	1.4	0.379

Source: U.S. Census Bureau historical data and projections from CPS Reports P25-1130. Average age over 20 computed using the midpoint in 5-year age intervals as the average age for all persons in that interval, and assuming that the average age for persons 85 and older is 90.

Table 5: "Predicted" Levels of Per Capita Asset Demand for Persons Aged 15 and Greater ($1995)

Year	Common Stock Holdings	Net Financial Assets	Net Worth
Predictions Based on 1995 Cross-Section from Survey of Consumer Finances			
1950	$ 14,639	$ 17,634	$ 86,930
1960	15,628	20,173	92,400
1970	15,216	20,332	89,717
1980	14,637	19,649	86,224
1990	15,043	19,980	88,773
2000	16,408	22,096	95,790
2010	17,615	25,016	101,905
2020	18,266	27,741	105,710
2030	18,479	29,432	106,688
2040	18,730	29,995	106,646
2050	18,703	29,988	106,526
Predictions Based on "Cohort Models" Estimated Using 1983-1995 Survey of Consumer Finances Data			
1950	12,457	32,031	86,608
1960	13,332	34,665	91,405
1970	12,982	34,146	88,611
1980	12,474	33,444	85,706
1990	12,736	34,250	88,101
2000	13,749	36,491	93,695
2010	14,953	39,584	99,600
2020	15,697	42,603	103,756
2030	15,709	43,896	103,957
2040	15,660	44,138	103,066
2050	15,690	44,202	103,248

Note: Each column reports the value of $\Sigma A_i * N_i$, where A denotes age-specific asset holdings (for five-year age groups) based on the 1995 SCF (upper panel) or the cohort wealth accumulation models (lower panel). N denotes the actual or projected number of individuals in a given age range in a given year. Tabulations apply to individuals aged 15 and greater. See text for further details.

Table 6: Demographic Structure and Real Returns on Stocks, Bonds, and Bills: Annual Regression Estimates

Asset Return and Sample Period	Independent Variable Measuring Demographic Structure				
	Median Age	Average Age of Those 20+	Percent of Population 40-64	(Population 40-64)/Population 65+	(Population 40-64)/Population 20 +
1926-1997					
Treasury Bills	-0.002 (0.002)	0.000 (0.003)	-1.787 (0.380)	-0.002 (0.006)	-0.409 (0.190)
LT Gov't Bonds	0.006 (0.006)	-0.006 (0.008)	-1.931 (1.076)	-0.001 (0.016)	-1.137 (0.476)
Common Stock	0.013 (0.012)	0.000 (0.016)	0.947 (2.137)	0.003 (0.030)	-0.148 (0.963)
1947-1997					
Treasury Bills	0.004 (0.002)	0.013 (0.005)	-0.694 (0.370)	-0.028 (0.007)	-0.275 (0.120)
LT Gov't Bonds	0.020 (0.008)	0.020 (0.023)	-0.962 (1.611)	-0.075 (0.034)	-1.078 (0.509)
Common Stock	0.023 (0.012)	-0.005 (0.035)	3.337 (2.418)	0.017 (0.054)	-0.065 (0.810)
1926-1975					
Treasury Bills	-0.021 (0.004)	-0.004 (0.004)	-2.573 (0.496)	0.015 (0.010)	-0.250 (0.466)
LT Gov't Bonds	-0.023 (0.008)	-0.017 (0.007)	-3.111 (0.980)	0.046 (0.016)	-1.447 (0.786)
Common Stock	0.010 (0.026)	-0.008 (0.020)	-0.287 (3.073)	0.027 (0.050)	-0.0018 (2.319)

Note: Each equation presents the results of estimating an equation of the form

$$R_t = \alpha + \beta^*(\text{DEMOGRAPHIC VARIABLE})_t + \varepsilon_t.$$

Standard errors are shown in parentheses. Equations are estimated using annual data for the sample period indicated.

Table 7: Changes in Demographic Structure and Real Returns on Stocks, Bonds, and Bills: Annual Regression Estimates

Asset Return and Sample Period	Independent Variable Measuring Demographic Structure				
	Δ(Median Age)	Δ(Average Age of Those 20+)	Δ(Percent of Population 40-64)	Δ((Population 40-64)/ Population 65+)	Δ((Population 40-64) /Population 20+)
1926-1997					
Treasury Bills	0.018 (0.028)	-0.011 (0.053)	4.680 (2.415)	0.396 (0.159)	1.840 (1.381)
LT Gov't Bonds	0.121 (0.069)	0.157 (0.134)	13.439 (6.054)	0.664 (0.413)	6.030 (3.459)
Common Stock	-0.063 (0.137)	0.379 (0.259)	4.063 (12.167)	0.173 (0.817)	9.059 (6.782)
1947-1997					
Treasury Bills	0.023 (0.019)	-0.003 (0.035)	4.305 (1.748)	0.430 (0.112)	1.256 (0.903)
LT Gov't Bonds	0.112 (0.078)	0.144 (0.145)	12.509 (7.608)	1.024 (0.519)	5.118 (3.815)
Common Stock	-0.035 (0.121)	0.435 (0.215)	15.433 (11.700)	0.673 (0.817)	11.995 (5.665)
1926-1975					
Treasury Bills	-0.017 (0.038)	-0.016 (0.072)	6.881 (3.920)	0.511 (0.300)	3.238 (2.429)
LT Gov't Bonds	0.078 (0.066)	0.136 (0.125)	17.675 (6.555)	-0.052 (0.537)	7.396 (4.169)
Common Stock	-0.133 (0.189)	0.428 (0.354)	-9.796 (20.001)	-1.489 (1.515)	10.009 (12.181)

Note: Each equation presents the results of estimating an equation of the form

$$R_t = \alpha + \beta * \Delta(\text{DEMOGRAPHIC VARIABLE})_t + \varepsilon_t.$$

Standard errors are shown in parentheses. Equations are estimated using annual data for the sample period indicated.

Table 8: "Long-Horizon" Evidence on Demographic Structure and Real Returns on Stocks, Bonds, and Bills, 1926-1997

Asset Return and Sample Period	Independent Variable Measuring Demographic Structure				
	Median Age	Average Age of Those 20+	Percent of Population 40-64	(Population 40-64)/Population 65+	(Population 40-64)/Population 20+
Level Specification for Demographic Variables					
Treasury Bills	-0.002 (0.005)	-0.001 (0.006)	-2.187 (0.579)	-0.001 (0.011)	-0.441 (0.330)
LT Gov't Bonds	0.007 (0.009)	-0.008 (0.011)	-2.576 (1.428)	0.001 (0.021)	-1.291 (0.551)
Common Stock	0.007 (0.009)	-0.008 (0.012)	0.023 (1.717)	0.013 (0.022)	-0.221 (0.706)
Change Specification for Demographic Variables					
Treasury Bills	0.032 (0.052)	-0.024 (0.102)	7.083 (4.951)	0.631 (0.341)	1.905 (2.797)
LT Gov't Bonds	0.168 (0.086)	0.162 (0.186)	24.447 (7.187)	1.243 (0.633)	8.625 (4.748)
Common Stock	-0.012 (0.105)	0.477 (0.150)	14.250 (9.920)	0.526 (0.760)	12.942 (4.326)

Note: Each equation presents the results of estimating an equation of the form

$$R_t = \alpha + \beta^*(\text{DEMOGRAPHIC VARIABLE})_t + \varepsilon_t$$

or the same specification with Δ(DEMOGRAPHIC VARIABLE)$_t$ as the independent variable. The equations are estimated using data for five-year non-overlapping intervals over the period 1926-1997. There are a total of 14 non-overlapping observations. Standard errors are shown in parentheses. For the "level" specification, the dependent and independent variables are five-year averages of the underlying annual variables. For the demographic change specifications, the independent variables are the average annual change over the five-year measurement interval.

Table 9: In-Sample and Out-of-Sample Predictions for Asset Returns Based on Simple Demographic Models

	Regression Model Using Demographic Variable:				
Asset Category and Year	Median Age	Average Age of Those 20+	Percent of Population 40-64	(Population 40-64)/ Population 65+	(Population 40-64)/ Population 20+
Level Specification, Table 1 Panel 1, 1926-1997 Sample Period					
Treasury Bills: 1990	0.002 (0.009)	0.007 (0.006)	0.012 (0.004)	0.009 (0.008)	0.022 (0.009)
2010	-0.006 (0.046)	0.006 (0.044)	-0.121 (0.046)	0.008 (0.042)	-0.017 (0.042)
2030	-0.008 (0.047)	0.004 (0.047)	-0.028 (0.038)	0.010 (0.043)	0.014 (0.041)
2050	-0.007 (0.047)	0.004 (0.048)	-0.022 (0.037)	0.010 (0.043)	0.015 (0.041)
LT Gov't Bonds: 1990	0.045 (0.023)	0.020 (0.015)	0.031 (0.013)	0.026 (0.020)	0.068 (0.021)
2010	0.072 (0.115)	0.004 (0.111)	-0.113 (0.130)	0.026 (0.107)	-0.041 (0.106)
2030	0.080 (0.119)	-0.011 (0.119)	-0.013 (0.107)	0.027 (0.110)	0.044 (0.103)
2050	0.078 (0.118)	-0.015 (0.122)	-0.006 (0.106)	0.027 (0.110)	0.047 (0.103)
Common Stock: 1990	0.137 (0.044)	0.096 (0.030)	0.094 (0.025)	0.094 (0.038)	0.102 (0.043)
2010	0.192 (0.224)	0.095 (0.217)	0.165 (0.258)	0.095 (0.208)	0.088 (0.215)
2030	0.208 (0.230)	0.094 (0.232)	0.115 (0.212)	0.092 (0.213)	0.099 (0.208)
2050	0.203 (0.228)	0.094 (0.237)	0.112 (0.210)	0.092 (0.213)	0.099 (0.208)
Change Specification, Table 2 Panel 1, 1926-1997 Sample Period					
Treasury Bills: 1990	0.010 (0.006)	0.007 (0.006)	0.016 (0.007)	0.021 (0.007)	0.013 (0.007)
2010	0.005 (0.042)	0.007 (0.042)	0.007 (0.041)	0.013 (0.041)	0.007 (0.042)
2030	0.007 (0.042)	0.007 (0.042)	0.000 (0.041)	0.012 (0.041)	0.005 (0.042)
2050	0.004 (0.042)	0.008 (0.042)	0.001 (0.041)	0.019 (0.041)	0.006 (0.042)
LT Gov't Bonds: 1990	0.042 (0.015)	0.036 (0.015)	0.052 (0.017)	0.049 (0.019)	0.046) (0.018)
2010	0.010 (0.105)	0.030 (0.106)	0.026 (0.103)	0.035 (0.105)	0.024 (0.105)
2030	0.022 (0.105)	0.031 (0.106)	0.003 (0.104)	0.034 (0.105)	0.017 (0.105)
2050	0.005 (0.105)	0.016 (0.106)	0.009 (0.103)	0.045 (0.106)	0.022 (0.105)
Common Stock: 1990	0.088 (0.030)	0.121 (0.029)	0.104 (0.034)	0.103 (0.038)	0.127 (0.033)
2010	0.105 (0.208)	0.107 (0.205)	0.097 (0.207)	0.099 (0.208)	0.094 (0.205)
2030	0.098 (0.207)	0.108 (0.205)	0.090 (0.208)	0.099 (0.208)	0.083 (0.205)
2050	0.107 (0.208)	0.074 (0.205)	0.091 (0.208)	0.102 (0.209)	0.090 (0.205)

Table 10: "Demographic Asset Demand" and Asset Returns

Asset Return	Common Stocks	Net Financial Assets	Net Worth
1926-1997, Level of Asset Demand as Independent Variable (Cross-Section Estimates)			
Treasury Bills	-0.205 (0.251)	-0.034 (0.096)	-0.042 (0.047)
LT Gov't Bonds	-0.663 (0.633)	-0.194 (0.242)	-0.130 (0.119)
Corporate Stock	0.308 (1.240)	-0.048 (0.473)	0.065 (0.234)
1926-1997, Level of Asset Demand as Independent Variable (Cohort Estimates)			
Treasury Bills	-0.005 (0.006)	-0.001 (0.002)	-0.001 (0.001)
LT Gov't Bonds	-0.018 (0.014)	-0.004 (0.005)	-0.003 (0.003)
Corporate Stock	0.005 (0.028)	0.001 (0.009)	0.002 (0.005)
1926-1997, Change in Asset Demand as Independent Variable (Cross-Section Estimates)			
Treasury Bills	0.008 (0.026)	-0.010 (0.018)	-0.284 (0.597)
LT Gov't Bonds	0.061 (0.064)	0.006 (0.046)	1.826 (1.496)
Corporate Stock	0.085 (0.125)	0.078 (0.089)	4.090 (2.899)
1926-1997, Change in Asset Demand as Independent Variable (Cohort Estimates)			
Treasury Bills	-0.065 (0.078)	-0.041 (0.033)	-0.009 (0.013)
LT Gov't Bonds	0.171 (0.198)	0.045 (0.085)	0.037 (0.033)
Corporate Stock	0.518 (0.382)	0.222 (0.163)	0.087 (0.065)
1926-1997, 5-Year Non-Overlapping Change in Asset Demand as Independent Variable (Cross-Section)			
Treasury Bills	-0.006 (0.056)	-0.033 (0.041)	-0 396 (1.123)
LT Gov't Bonds	0.071 (0.104)	-0.071 (0.104)	2.412 (2.006)
Corporate Stock	0.056 (0.112)	0.055 (0.082)	4.964 (1.751)
1926-1997, 5-Year Non-Overlapping Change in Asset Demand as Independent Variable (Cohort Estimates)			
Treasury Bills	-0.081 (0.146)	-0.048 (0.061)	-0.011 (0.025)
LT Gov't Bonds	0.244 (0.269)	0.066 (0.116)	0.049 (0.045)
Common Stock	0.632 (0.234)	0.257 (0.101)	0.106 (0.040)
1947-1997, Level of Asset Demand as Dependent Variable (Cross-Section)			
Treasury Bills	0.669 (0.445)	0.540 (0.179)	0.093 (0.078)
LT Gov't Bonds	0.679 (1.916)	0.773 (0.813)	0.075 (0.335)
Common Stock	2.578 (2.899)	-0.545 (1.248)	0.489 (0.506)
1947-1997, Change in Asset Demand as Dependent Variable (Cross-Section)			
Treasury Bills	0.018 (0.020)	-0.003 (0.014)	0.025 (0.410)
LT Gov't Bonds	0.139 (0.081)	0.060 (0.152)	1.898 (1.707)
Common Stock	0.173 (0.125)	0.152 (0.090)	5.923 (2.493)

Note: Each entry reports the regression coefficient, and standard error (in parentheses), from a regression with the real asset return as the dependent variable, and the indicated demographic demand variable as the independent variable.

Table 11: Regression Evidence Relating Asset Returns to Logged Population Shares in Various Age Groups

Asset Return	Treasury Bills	LT Gov't Bonds	Corporate Stock
1926-1997 Sample			
Log share < 5	-0.136	0.362	-2.324
	(0.346)	(1.117)	(2.301)
Log share 5-14	-0.260	0.881	-4.543
	(0.611)	(1.973)	(4.063)
Log share 15-24	-0.376	0.628	-4.905
	(0.580)	(1.870)	(3.852)
Log share 25-34	-0.339	0.665	-3.901
	(0.554)	(1.788)	(3.682)
Log share 35-44	-0.132	1.005	-2.838
	(0.444)	(1.434)	(2.953)
Log share 45-54	-0.537	-0.072	-2.819
	(0.345)	(1.112)	(2.290)
Log share 55-64	0.090	0.606	0.901
	(0.220)	(0.711)	(1.464)
Log share 65-74	-0.614	-0.683	-3.532
	(0.282)	(0.911)	(1.876)
Log Share 75+	0.143	0.567	-0.450
	(0.200)	(0.645)	(1.328)
Adjusted R2	0.453	0.108	-0.001
1947-1997 Sample			
Log Share < 5	0.242	-0.672	-1.334
	(0.490)	(2.866)	(4.506)
Log share 5-14	0.137	-2.624	-3.729
	(0.961)	(5.617)	(8.831)
Log share 15-24	0.084	-2.634	-3.859
	(0.906)	(5.294)	(8.323)
Log share 25-34	0.046	-1.882	-2.955
	(0.787)	(4.598)	(7.229)
Log share 35-44	0.313	-2.414	-2.475
	(0.861)	(5.032)	(7.911)
Log share 45-54	-0.001	-2.804	-2.147
	(0.732)	(4.279)	(6.728)
Log share 55-64	0.844	-1.776	0.624
	(0.704)	(4.117)	(6.473)
Log share 65-74	-0.308	-4.268	-3.250
	(0.677)	(3.955)	(6.218)
Log share 75 & up	0.316	0.768	0.065
	(0.210)	(1.226)	(1.927)
Adjusted R2	0.518	0.738	0.014

Notes: See text for further discussion.

Table 12: Predicted Values for Asset Returns, 1990-2050, Based on Log Population Share Regressions, 1926-1997 Period

Predicted Return in Year:	Treasury Bills	LT Gov't Bonds	Corporate Stock
1990	0.029 (0.011)	0.103 (0.036)	0.086 (0.074)
2000	0.057 (0.063)	0.106 (0.202)	0.714 (0.417)
2010	0.065 (0.154)	-0.072 (0.496)	1.644 (1.021)
2020	0.041 (0.194)	-0.250 (0.626)	1.630 (1.290)
2030	0.045 (0.188)	-0.290 (0.607)	1.268 (1.251)
2040	0.165 (0.188)	-0.119 (0.606)	1.790 (1.248)
2050	0.203 (0.191)	-0.051 (0.616)	1.937 (1.268)

Note: Each entry reports the predicted in sample (1990) or forecasted out-of-sample value from the regression equations shown in the first panel of Table 11. Standard errors of prediction (for 1990) or forecast (all other years) are shown in parentheses.

Table 13: Percent of the Population Aged 40-64 and Asset Returns, Canada and the United Kingdom

Asset Category	Canada		United Kingdom	
	Level of Demographic Variable	Difference of Demographic Variable	Level of Demographic Variable	Difference of Demographic Variable
Treasury Bills (50--97 Canada, 50-96 U.K.)	0.766 (0.234)	9.803 (1.923)	-0.333 (0.334)	4.474 (2.395)
LT Gov't Bonds (50--97 Canada, 50-96 U.K.)	0.893 (0.206)	10.339 (1.698)	-0.164 (0.274)	4.015 (1.940)
Corporate Stock (61--97 Canada, 61-96 U.K.)	0.903 (1.588)	6.252 (16.143)	-2.174 (3.048)	5.988 (18.371)

Notes: See text for further discussion.