Household Portfolio Allocations, Life Cycle Effects and Anticipated Inflation*

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November 2002

Abstract

Stocks, bonds and money play different roles in an individual's portfolio. We examine data from various Wealth Supplements of the PSID and document portfolio patterns over the life cycle. In order to account for observed holding patterns, we construct a stochastic overlapping generation model. In the model, individuals are *ex ante* identical, but are subject an uncertain life expectancy and income uncertainty. Individuals attempt to smooth consumption by holding on money, bonds and real capital. We show that the model is able to replicate life cycle portfolio allocations. Because money holding patterns are age dependent, we use the model to examine the portfolio effects of inflation. We find that inflation has modest effects on household portfolio compositions. The largest effects occur for households between age 45 and age 65.

*We have benefited from the comments of Carlos Garriga, S. Chaterjee, Ayse Ìmrohoroğlu, Ed Prescott, and especially Eric Young. An earlier version of this paper was presented at the 2001 Meeting of the Society for Economic Dynmaics.

1 Introduction

In recent years, there has been a great amount of interest in trying to understand household portfolio behavior over the life cycle. The motivation for this interest, in part, comes from the aging of the baby boom generation and the implications of aging for social security systems and the level of private and national savings. A substantial theoretical literature has considered age-related patterns of asset allocation in terms of the standard portfolio choice paradigm.[1] Recently, the question of the relationship between age and portfolio allocation has been investigated empirically. Canner, Mankiw, and Weil (1997) examine whether investors who are more risk averse, such as older individuals, hold more riskless assets in their portfolios. Such behavior does not appear to be consistent with the mutual fund separation theorem. Poterba and Samwick (2000) examine saving behavior from a demographic perspective and find that the composition of an individual's portfolio varies over the life cycle.

In this paper we examine the Wealth Supplements to the PSID and document how currency, bond and stock holding varies with wealth levels as well as an agent's life cycle. Stockholding is characterized by a humped shaped pattern over the life cycle with the peak occurring in the mid fifties. In contrast, money plays a very important role for young and old individuals. Our data suggest that the fraction of the portfolio allocated to money has a "U-shaped" life cycle pattern. The life cycle pattern of bond holding in the portfolio seems to increase with age until retirement. Because we find that portfolio composition depends on age, we construct a stochastic overlapping generation general equilibrium model where individuals live in an uncertain environment and attempt to smooth consumption through savings. Individuals have access to three savings vehicles to insure against income fluctuations - real capital, government bonds, and money. Markets are incomplete as negative positions are not possible in each asset. Money is also required for consumption purposes. Aggregate shocks are not present in the model. We calibrate and solve our model numerically. We find that the model can account for most of the observed portfolio allocation patterns. Since money holdings play an important role in the portfolio of younger and older individuals, we use the model to examine how alternative (anticipated)

[1] Some of the papers that have examined the theoretical implictions of age for portfolio allocations are Bodie, Merton and Samuelson(1992), Campbell, Cocco, Gomes, and Maenhout(1999), Gakidis(1997), Hochguertel(1998), Kimball(1993), and Samuelson(1989,1999).

inflation levels impact individuals portfolio allocation decisions. We find that increased inflation has modest effects on household portfolios. As inflation increases, households reallocate their portfolios by decreasing money holdings, and increasing stock holdings. These effects are particularly strong for households between ages 45 and 65. This pattern is robust to aggregate asset levels as well as portfolio shares. Bond holdings are hardly affected by increased inflation. These portfolio effects can be translated into aggregate effects. Aggregate stock holdings and consumption increase with higher inflation. Since the rate of return on money falls with increased inflation, we also find that aggregate money holdings fall with inflation. Given that consumption and money holdings move in opposite directions, precautionary money holdings fall significantly as inflation rises. We also find significant changes in aggregate prices at different levels of anticipated inflation. We find that as the rate of inflation increases, the rate of return on stocks falls, the discount price of bonds rises, the price level on goods increases, and the budget balancing income tax rate increases. The increase in the price of the discount bonds implies that the risk-free interest rate and the level of anticipated inflation are inversely related.[2]

It is interesting to compare our results to Chatterjee and Corbae (1992). They study an economy where individuals live two periods and are faced with different endowments. Agents have access to money and costly credit to smooth consumption. Their paper analytically studies the individual's decision to participate in the costly credit or bond market. They find that changes in the money growth rate have a negative effect on real interest rates because of changes in asset type holdings. The real interest rate change results in a redistribution of wealth. Our model is much more general than their model and our numerical work allows us to examine the quantitative size of their redistribution channel.

This paper is organized into four sections. In the first section, we report the results from an analysis of a data set we developed from Wealth Supplements to the PSID. This data set allows us to examine how individuals or

[2] Erosa and Ventura(2002) examine a heterogeneous agent framework where infinitely lived agents have access to money, costly credit and capital in order to smooth out income fluctuations. The focus of their paper is different from our paper in that they examine the distribution costs of inflation. They find that low income individuals in contrast to higher income individuals do not have access to credit and thus hold large cash balances. This is consistent with the fact that young and low income individuals have relatively large cash positions.

family units distribute their wealth across various assets over their lifetime. The second section develops the model and defines the stationary equilibrium for this model. The third section discusses how we calibrate the model as well as numerically solve the model. The fourth section analyzes the empirical results generated by the model as well as how portfolios are affected by inflation. The final section concludes.

2 The Data

In the model that we construct, individuals attempt to smooth consumption in an environment with incomplete markets. They save for precautionary reasons and can allocate their savings over three vehicles - stocks, bonds, and money. In order to evaluate the performance of the model, we must document how individuals actually allocate their savings over a similar set of assets over their lifetime. Because the focus of the model is a family or individual, we must assemble facts on individual or family asset holding over the life-cycle. This requires an examination of a panel data set. Two data sets are frequently used to study life cycle savings decisions. These are the *Survey of Consumer Finances* from the Board of Governors and the University of Michigan's *Panel Survey on Income Dynamics* (PSID). Because the latter data set allows researchers to track individual family units and their adult offspring over time, we focus on the 1994 Wealth Supplement to the PSID.[3]

Income,wealth and asset holding position information for the family unit is compiled. We follow the definitions in Budría, Díaz-Giménez, Quadrini and Ríos-Rull (2002). That is, net wealth is defined as the sum of house value less remaining mortgage principle, the net value of other real estate holdings, the net value of vehicles, equity in farms or private business, cash (checking and saving accounts, money market bonds, Treasury bills, including such assets held in IRA's), bonds (bond funds, cash in life insurance policies, a valuable collection for investment and rights in trusts or estates), and stocks (shares of stocks in publicly held corporations, mutual funds, or investments trusts including stocks in IRA's).[4]

[3]We assembled a panel data set based on family units from the 1984, 1989, and 1994 Wealth Supplements to the PSID. Because the general trends generally carry over all the samples, we focus on the 1994 Wealth Supplement in this paper for the sake of brevity. We also examined the 1998 Survey of the Survey of Consumer Finances and found similar holding patterns.

[4]A comment is required on how we constructed our sample. The sample of households

In Table 1 we summarize individual portfolio allocations across the wealth distribution. We create average holding values by finding the average wealth (as defined in the PSID) for all individuals with nonnegative wealth. From these values we constructed allocation shares for cash, bond and stock holdings. In addition, we create a measure of financial wealth which is the sum of money, bond, and stock holdings. The primary difference between wealth and financial wealth is housing and real estate. Since housing issues are not studied in this paper, financial wealth is the appropriate measure of wealth for the model we construct.[5] Thus, when we refer to a portfolio, we are referring to a financial portfolio. The values in Table 1 are in current value terms. We find that individuals hold a large fraction of liquid assets in their portfolios. Data from the 1994 Wealth Supplement suggests that 52.4 percent of financial wealth is held in the form of cash. Bond holdings account for 19.5 percent of financial wealth holdings while stocks accounted for 28.03 percent.[6]

Portfolio allocations by quartiles are also presented in Table 1. The lowest wealth quartile is defined as the first quartile. The fourth quartile has the vast majority of wealth holdings. In fact, the average wealth level of the fourth quartile is fifty-three times larger than the first quartile. The fourth quartile holds the largest amount of all three assets. It is of interest to know how individuals in the different quartiles allocate their wealth. Individuals in the first quartile hold most of their portfolio in liquid assets. Individuals that comprised the first quartile hold approximately 70.9 percent of their

we examine is motivated by a desire to have a dynamic panel over the various Wealth Supplements. In constructing this sample we decided to assemble an unbalanced panel to maximize the number of family units as well as allow younger households to endogenously appear in the sample. We hoped that this strategy would minimize bias against younger individuals that often occurs in a balanced sample. We also had to delete some family units. A number of family units did not appear in all wealth supplements. This could be do to either their dropping from the survey or death. We tried to differentiate these two possibilities. If an individual was over 65 years of age and did not appear in the following supplement, we assume the individual died and kept the individual in the sample. If the individual was under 65, we assumed the individual failed to respond and hence we deleted the person from our sample. Divorces can have major implications for portfolio decisions. Since we did not model the divorce issue in this paper, we decided to delete family units that suffered a divorce. We also eliminated a household if they reported negative wealth.

[5] See Platania and Schlagenhauf (2000) for a study on housing over the life-cycle.

[6] The fraction of stocks in the financial portfolios appears to be too low. This can be attributed to a weakness of PSID data. The PSID under samples the wealthy who would have the largest amount of stock holding.

financial portfolio in liquid assets. The fraction of financial wealth held as bonds is 17.62 percent while only 11.41 percent of the portfolio is in stocks. The second quartile holds a much smaller fraction of their wealth in cash, about the same amount on bonds, and a slightly larger percentage of their portfolio in stocks. Financial portfolio allocations of the third quartile are very similar to the second quartile. Individuals in the third quartile seem to hold a slightly larger fraction of their wealth in the form of stocks. The financial portfolio allocation of individuals in the fourth quartile substantially differ from the allocations of the first quartile. Individuals in the wealthiest quartile hold a large percentage of stocks. As can be seen, 46.4 percent of the financial portfolio is held as stocks in the fourth quartile. Liquid assets account for 34.98 percent of fourth quartile portfolio. In contrast the first quartile financial portfolio held 70.9 percent in the form of liquid assets.[7]

In Table 2, we examine portfolio allocations over the life-cycle. Both young and old individuals seem to allocate a larger fraction of their wealth to liquid assets. Individuals in the 18 to 24 age cohort allocate 65.5 percent of their portfolio to liquid assets. Individuals in the oldest cohort, 75 years and older, hold 61.8 percent in the form of liquid assets. Individuals in the other age cohorts allocate less of the financial portfolio to liquid assets. In fact, the percentage of the portfolio held in cash seems to have a "U-shaped" pattern with the 55-64 cohort having the lowest percent of wealth in cash. Figure 1 presents the fraction of wealth in the form of cash, bonds, and stocks for ages 21 to 85. Since this fraction varies by age, we attempt to smooth out some of the variation by using a three year moving average. The smoothed data are the represented by the bolder curve in the figure an the ”U-shaped” pattern is very apparent. Ameriks and Zeldes (2001) examination of panel data from the Survey of Consumer Finances and find that individuals with less financial wealth hold relatively more cash. This finding is consistent with our finding that the younger individual tends to hold a large amount of liquid assets. Poterba and Samwick (1999), using data from the Survey of Consumer Finances find that older cohorts of households tend to devote a higher fraction of their portfolio to liquid assets.

Bond holding has a different pattern over the life-cycle. We already established that young individuals hold a large percentage of their financial

[7] This fact is consistent with Avery (1987), Kessler and Wolff(1991), and Kennickell and Star-McCluer(1996) who find the fraction of household wealth held in liquid assets decreases with income and wealth.

portfolio in the form of liquid assets. We also find that these same individuals hold a relatively large amount of bonds. Individuals in the 18 to 24 age cohort hold approximately 30 percentage of the financial portfolio in the form of bonds. As individuals age, this fraction of the financial portfolio allocated to bonds steadily declines. For example, individuals in 65 to 74 age cohort only hold 9.3 percent of their portfolio in the form of bond and individuals in the 75 and over cohort hold only a 5 percent share. Figure 1 presents bond shares by age and clearly shows a declining trend. This result is somewhat surprising. Financial planners often argue than retired individuals should hold more of their portfolio in safer assets with bonds being one of these assets. We do not find the fraction of the portfolio allocated to bonds increasing at the higher age cohorts.

Stock holding over the life cycle seems to suggest a humped shaped pattern. Younger individuals hold a relatively small fraction of financial wealth in the forms of stocks. For example, individual in the 18-24 age group in the 1994 Wealth Supplement held approximately 4.5 percent of there portfolio in the form of stocks. This fraction increases and seems to peak around of the time of retirement.[8] After the 65 to 74 age cohort, there is some evidence that individuals allocate a smaller fraction of their financial portfolio to stocks. Figure 1 presents stock holdings as a percentage of financial wealth portfolio. The humped-shaped pattern characterizing stock holding over the life cycle is not unique to the PSID data set. Ameriks and Zeldes (2001) examine a panel data set that pools cross-section data from the Survey of Consumer Finance and a panel data set from TIAA-CREF. They find equity ownership has a humped-shaped pattern with peak of the hump occurring in the 52-55 age cohort. Bertaut and Starr-McCluer (2000) examine household portfolios using the Survey of Consumer Finances. Defining risky assets as stocks, corporate, foreign, and mortgage-backed bonds, they find that the share of households having risky financial assets is humped-shaped with the largest share occurring in the 45-54 age group in the 1989 and 1992 survey and in the 55-64 age group in the 1995 and 1998 survey. Our findings are in line with these other studies.

Our analysis of panel data indicates that financial portfolio choices depend on both age and wealth levels. These findings are important for three reasons. First, these facts show that any study of portfolio allocations must

[8] The data from the 1994 Wealth Supplement indicated that the share of stocks in the wealth portfolio is greatest in the 65-74 age cohort and then declines.

allow for the role played by age. This suggests that the appropriate model for studying household portfolios must explicitly recognize age. An overlapping generations model satisfies this criteria. Second, these facts serve as a benchmark for evaluating the predictions of any model of portfolio allocation. Third, since bonds, stocks, and liquid assets make up a substantial elements in portfolios, a model should allow for choices over these assets.

3 The Model Economy

In this section, we describe the model we use to study household portfolios. This model contains three sectors: households, firms, and a government. The modeled economy is populated by overlapping generations of *ex ante* identical households. Each individual is subject to idiosyncratic productivity shocks and an uncertain length of life. In an attempt to insure against these shocks and smooth consumption over their lifetime, households hold a financial portfolio comprised of stocks or real capital, government bonds, and/or currency. A firm sector produces goods that can be used for either consumption or capital purposes. Since all firms are assumed to be identical, we consider a representative profit maximizing firm. The production of this good requires capital and labor input. This economy also contains a government sector. In the consolidated government budget constraint, the government purchases goods, pays retirement benefits, and pays interest on government debt by issuing currency and bonds as well as through an income tax and a retirement tax on workers. We now proceed with a more in-depth description of each sector.

3.1 The Household Sector

In each period time period a new generation of households is born with probability $\psi_1 = 1$. Each new generation starts with zero assets. The bequest motive is not modeled in this paper. The maximum length of life is J periods. However, the survival between periods is uncertain. Let the probability of survival from age j to age $j+1$ be $\psi_{j+1} \in (0,1)$. The share of age-j individuals in the economy is denoted by $\mu_j \geq 0$. The shares are determined by $\mu_j = \psi_j \mu_{j-1}/(1-\rho)$ for $j = 2, 3, ..., J$ and $\sum_{j=1}^{J} \mu_j = 1$, where ρ denotes the rate of population growth.

3.1.1 Preferences

Individuals are only concerned with their future consumption if they are alive and are assumed to order their consumption choices according to

$$E_0 \sum_{j=1}^{J} \beta^j \left[\Pi_{k=1}^{j} \psi_k\right] U(c_j, g_j) \tag{1}$$

where U is a continuous and strictly concave utility function; c_j is household consumption at age j which is restricted to being nonnegative; g_j is the household share of government spending at age j, β is the subjective discount factor; and E_0 is the expectation operator conditional on information at birth. We assume that government spending enters the utility function in a separable manner. This allows us to ignore government spending in household problem as it only serves as a scaling mechanism for lifetime utility.

3.1.2 Earning Opportunities

An individual is endowed a unit of time in each period and they supply this time endowment to the labor market inelastically up to the retirement age $j^* < J$. The retirement age is the same for all individuals. Individuals differ in their productivity for two reasons. First, individuals of different ages have different productivities. We define ε_j as the labor productivity of an age j individual. The age profile of average labor productivity is $\{\varepsilon_j\}_{j=1}^{j^*}$. A second factor explaining individual differences in labor productivity is an individual-specific component which we denote as ξ. We assume that individual-specific labor productivity follows a finite state Markov chain with a state space $\xi \in \Xi = \{\xi_1, \xi_2, ..., \xi_N\}$ and transition probabilities given by the matrix $\pi(\xi'|\xi)$ where ξ' is the labor productivity shock in the next period. Define Π as the unique invariant measure associated with π. We assume all agents irrespective of age face the same Markov transition probabilities and that the fraction of the population experiencing a transition from ξ to ξ' is also given by π.[9] From the law of large numbers and the assumed demographic structure in the model, the aggregate labor input will be constant. These assumptions allow us to define an individual's labor earnings in a given period as $w\xi\varepsilon_j$. In this model, we assume markets do not exist that allow individuals to directly insure against these individual-specific differences in labor productivity.

[9] The initial realization of the individual-specific labor productivity is assume to be drawn from Π for all agents.

3.1.3 Household Decision Problem

Each period individuals must decide how much to consume and how much to save. Households have access to three saving vehicles: non-interest earning money balances of m_{t+1}, government bonds of γb^g_{t+1} which sell at the discount price $q_t$where γ is the denomination, and/or capital, $k_{t+1.}$ The saving and consumption decisions are constrained by the sources of income available to an individual. Each period, a working individual earns wage income equal to $w\xi\varepsilon_j$. This wage income is subject to an income tax, τ_y, and a retirement tax, τ_r. A retired individual does not earn any wage income, but does receive a retirement income of y_r. Saving decisions made in the prior period provide additional sources of income. These sources include money balances of m_t, bonds of γb^g_t, net capital income $(1-(1-\tau_y)(r_t-\delta))k_t$, as well as the monetary transfer, $\widetilde{m}_t$, if the individual is in the first period of economic life. The decisions to change capital stock holding involve a trading cost. We assume that the costs of trading stock are proportional to the value of trade. We can write the household's budget constraint in terms of the consumption good as:

$$\begin{aligned} c_t + m_{t+1}e_t + q_t\gamma b^g_{t+1} + k_{t+1} \quad \leq \quad & [1-\Theta](1-\tau_y-\tau_r)w\xi\varepsilon_j + \Theta y_{s,j} \\ & + m_t + [1-\Omega]\widetilde{m}_t \\ & \gamma b^g_t + (1+(1-\tau_y)(r_t-\delta))k_t - tc(|k_t-k_{t+1}|) + tr_t \end{aligned} \tag{2}$$

where tc is transaction costs associated with changes in capital stock holdings, δ is the depreciation rate on capital, r_t is the interest return on capital, tr_t denotes the individual's share from accidental bequests, and Θ and Ω are indicator functions. Θ is an indicator that takes on the value of 0 is the individual is of age $j < j*$ or the value 1 if $j \geq j^*$. Ω is an indicator that takes on the value of 0 is the individual is of age $j = 1$ or the value 1 if $j > 1$. That is,

$$\Theta = \begin{cases} 0 \text{ if } j < j^* \\ 1 \text{ if } j \geq j^* \end{cases}$$

and

$$\Omega = \begin{cases} 0 \text{ if } j = 1 \\ 1 \text{ if } j > 1 \end{cases}$$

In this model, individuals hold money, bonds, and stocks so as to smooth out fluctuations in consumption due to the fact that markets are incomplete.

In our model, individuals hold money for a secondary reason. Following Lucas (1982), we assume that households need money balances in order to purchase consumer goods. In a model with incomplete markets, we will see that some agents will hold money balances for precautionary reasons as well as the transactions reasons that are normally captured by the cash-in-advance constraint. In sum, the cash-in-advance constraint for this economy is

$$m_t \geq c_t$$

We can now restate the household's problem recursively. From this point forward, a variable in the next period will be denoted by the prime notation. At each moment in time, individuals are differentiated by their holding of money, bonds, capital, productivity shock and age. Let $V(m, b^g, k, \xi, j)$ be the value of the objective function of age-j agent with beginning-of-period asset holdings of m, b^g, k, and productivity level ξ. The recursive formulation of this problem is:

$$V(m, b^g, k, \xi, j) = \max_{\{c, m', b^{g\prime}, k'\}} U(c) + \beta\psi_{j+1} \sum_{\xi'} \pi(\xi'|\xi) V(m', b^{g\prime}, k', \xi', j+1) \tag{3}$$

subject to the budget constraint

$$\begin{aligned} c_t + m_{t+1}e_t + q_t\gamma b^g_{t+1} + k_{t+1} \quad \leq \quad & [1-\Theta](1-\tau_y-\tau_r)w\xi\varepsilon_j + \Theta y_{s,j} \\ & +m_t + [1-\Omega]\widetilde{m}_t \\ & \gamma b^g_t + (1+(1-\tau_y)(r_t-\delta))k_t - tc(|k_t - k_{t+1}|) + tr_t \end{aligned}$$

a cash-in advance constraint

$$m \geq c$$

and constraints

$$c \geq 0$$

$$b^g \geq 0, \; m \geq 0, \; k \geq 0$$

We assume the household can not short sell capital.

3.2 The Firm Sector

We assume a large number of perfectly competitive firms exist in the economy. As a result, we model the firm sector as being comprised of one aggregate representative firm that attempts to maximize profits. The production technology of this firm is given by a constant return to scale Cobb-Douglas function

$$Y = f(K, N) \equiv K^{\alpha} N^{1-\alpha}$$

where $\alpha \in (0, 1)$ is capital's share of output, K and N, are aggregate inputs of capital and labor, respectively.

Given a competitive environment, the profit-maximizing behavior of the firm gives rise to first-order conditions which determine the real return to capital and the real wage

$$r = \alpha K^{\alpha-1} N^{\alpha} \tag{4}$$

and

$$w = (1 - \alpha) K^{\alpha} N^{-\alpha} \tag{5}$$

3.3 The Monetary/Government Authority

The monetary authority/government purchases goods, pays retirement benefits, and pays interest on government debt. These purchases are financed through an income tax on wage and capital earnings, bonds and by issuing currency. Currency bears no interest and determines the unit of account. This aggregate money stock is denoted by M. A bond promises to deliver one unit of goods at the beginning of the next period. This bond sells at a discounted price of q_t. We will denote the supply of bonds by B^g. This assets can be thought of as a T-bond. We assume that these bonds are large denomination bonds of size γ as in Díaz-Giménez and Prescott (1992).

The monetary authority passively supplies bonds to pay off government debt. The monetary authority sets the monetary growth rate, ζ, exogenously. The money supply growth is exogenous and constant. In the absence of an aggregate shock, we assume there is no uncertainty about the money supply process. The monetary authority uses seigniorage revenues from inflationary monetary policy to finance the interest payments on government bonds. Thus, the aggregate nominal supply of money equation is:

$$M_{t+1} = (1 + \zeta) M_t \tag{6}$$

Let p_t be the price of one unit of the good produced in period t. The inflation rate is simply $e_t = p_{t+1}/p_t$. It is easy to show that the monetary growth rate ties down the inflation rate. Specifically, the growth of the money supply equals the inflation rate.

We assume that retirement program is self financing. That is,

$$\tau_r \sum_{j<j^*} \mu_j w \xi \varepsilon_j = \sum_{j \geq j^*} \mu_j y_s$$

where μ_j is the measure of age j individuals.

The consolidated government budget constraint in real terms is:

$$\tau_y(N + (r - \delta)K) + q_t \gamma B^g_{t+1} + \frac{(e_t - 1)M_{t+1}}{p_t} = D_t + G_t - \frac{\widetilde{M}_t}{p_t} \tag{7}$$

where D_t is the fixed size of the government debt, and $\widetilde{M}_t$ is the total monetary transfers given the first generation.[10]

3.4 Definition of Stationary Equilibrium

We can formally define the stationary equilibrium for this model. Let $m \in \Upsilon, b^g \in \Phi, k \in \Delta, \xi \in \Xi$, and $j \in J$ where $\Upsilon \subset \mathbb{R}_+$, $\Phi \subset \mathbb{R}_+$, $\Delta \subset \mathbb{R}_+$, $\Xi = [\xi_1, \xi_2, ..., \xi_N]$, and $J \subset \mathbb{R}_+$. Let $X = \Upsilon \times \Phi \times \Delta \times \Xi \times J$. For each $S \in S(X)$, where $S(X)$ is an appropriate collection of subsets of X, let $\Lambda(S)$ denote the measure of age specific individuals with $(m, b^g, k, \xi, j) \in S$. The fraction $\mu_j \Lambda(S)$ denotes the measure of age-j agents with $(m, b^g, k, \xi, j) \in S$ with respect to the entire population of agents in the economy.

Definition 1 *A stationary equilibrium is a value function V, policy functions for the household $(c, m', b^{g\prime}, k')$, policy functions for the government authority $(M'_, B^{g'}, \zeta, \tau_y, \tau_r)$, input demands for the representative firm, prices (w, r, q, P), accidental bequests tr, and a finite age-dependent and time-invariant measures of agent types $\Lambda(m, b^g, k, \xi, j) \in M$ such that:*

[10] In an overlapping generation model we agents are cash constrained, a first period problem occurs. In order to have first period consumption in the youngest cohort, these individuals must have access to money this means the initial generation must be given some cash transfer arebe allowed to use current wage receipts to acquire money. Since we want the consumers budget constraint to be the same in all periods, we give the youngest individuals some monetary transfers.

1. Given (w, r), the monetary authority policy $(M', B^{g\prime}, \zeta)$, and accidental bequests, V solves the functional equation (7) and $c(m, b^g, k, \xi, j), m'(m, b^g, k, \xi, j), b^{g\prime}(m, b^g, k, \xi, j), k'(m, b^g, k, \xi, j)$ are the household's policy functions.

2. The input prices $\{w, r\}$ are consistent with the firm's profit maximization problem by satisfying equations (3) and (4).

3. All markets clear

Goods Market:

$$\begin{aligned} f(K, N) &= \sum_j \mu_j \int c(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \\ &+ \sum_j \mu_j \int k'(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \\ &- (1-\delta) \sum_j \mu_j \int k(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \end{aligned} \tag{8}$$

Capital Market:

$$K = \sum_j \mu_j \int k(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \tag{9}$$

Bond Market:

$$D = \sum_j \mu_j \int b^g(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \tag{10}$$

Money Market:

$$\frac{M}{p} = \sum_j \mu_j \int m(m, b^g, k, \xi, j) d\Lambda(m, b^g, k, \xi, j) \tag{11}$$

Labor Market:

$$N = \sum_j \mu_j \int \xi \varepsilon_j d\Lambda(m, b^g, k, \xi, j) \tag{12}$$

4. Accidental transfers which depend on accidental deaths are defined as:

$$\begin{aligned} tr &= [\sum_{j=1}^{J} \mu_j \int (1-\psi_{j+1})[m'(m,b^g,\xi,j) + b^{g\prime}(m,b^g,\xi,j) \\ &\quad + k'(m,b^g,\xi,j)] d\Lambda(m,b^g,\xi,j)] \end{aligned}$$

5. The social security system is self-financing, satisfying

$$\tau_r \sum_{j<j^*} \mu_j w \xi \varepsilon_j = \sum_{j\geq j^*} \mu_j y_s$$

6. The government budget constraint is satisfied.

$$\tau_y(N + (r-\delta)K) + q_t \gamma B^g_{t+1} + \frac{(e_t - 1)M_{t+1}}{p_t} = D_t + G_t - \frac{\widetilde{M}_t}{p_t}$$

7. The collection of age-dependent, time invariant measures satisfy

$$\Lambda(m', b^{g\prime}, k', \xi', j+1) = \int \Pi(\xi', \xi) d\Lambda(m, b^g, k, \xi, j)$$

with $\Lambda(0,0,0,\xi,1)$ *given. Note that the newborns do not enter with any assets indicating no planned bequests exist in the model.*

4 Calibration and Computational Issues

4.1 Calibration

The model can not be solved analytically. As a result the model must be solved numerically if we are going to evaluate whether agents desire to save for precautionary reasons is sufficient to explain observed asset holdings over the life cycle. This means we must specify functional forms and choose parameter values. We have attempted to choose parameters so the model is consistent with the behavior of the U.S. economy during the post war period.

The demographic structure of the model requires the specification of the age length and efficiency index by age for an individual as well as the size of each cohort in the U.S economy. We calibrate our model period to be one year. Individuals are assumed to be born when they are of age 21, and they can live to a maximum age of 85 years. In terms of model time, individuals live 65 periods. We assume every individual must retire at age 65. The size of each cohort by age, μ_j, is calculated from the relation $\mu_{j+1} = \psi_{j+1}\mu_j/(1+\rho)$ and $\sum_{j=1}^{J} \mu_j = 1$. The parameter ρ is the growth rate of the population. We set this coefficient equal to zero in the baseline model. The conditional survival probabilities, ψ_j,are from Farber (1982).

The model allows workers of different ages to have different productivity values. We make this assumption in an attempt to provide a realistic cross-sectional age distribution of earnings. We calibrate $\{\varepsilon_j\}$ to the age-earnings profile of money earnings for full-time male and female workers.[11]

The technology parameters that need to be specified are determined by the functional form of the aggregate production function and the capital evolution equation. The aggregate production function is assumed to have a Cobb-Douglas form. As in the real business cycle literature, we want to specify labor's share to income, $1-\alpha$, to be consistent with the long-run share of national income in the U. S.. We specify labor's share to be 0.67 which is close to the value specified in Cooley and Prescott (1995).

Before any preference parameters can be calibrated, we must specify the functional form of the momentary utility function. We assume that the utility function has a CRRA form, $U(c) = (1-\sigma)^{-1}c^{1-\sigma}$. Following from the real business cycle literature, we set the coefficient of relative risk aversion, σ, to be 1.5.

The parameters β, δ, G, D, and τ_r are calibrated so that the model is consistent with the postwar United States economy. The discount factor β is set so that a capital-output ratio of 3.0 is matched by the baseline model. This occurs when $\beta = .995$. The depreciation rate, δ, is calibrated by the investment-capital ratio. For the postwar US economy, this number is .05. The value of government consumption is set to be consistent with the postwar government spending (except for transfer payments) output ratio of 0.22. This implies the baseline value for G to be .31. The parameter D is tied down by the Privately held Debt-GDP ratio. During the postwar period, the average Debt to GDP ratio is 0.30. As a result, the baseline value

[11] The data are from the U.S. Bureau of the Census, "Money Income of Households, Families, and Persons in the United States, 1990," *Current Population Reports,* Series P-60, No. 174, August 1991(Table 30).

of D is 0.42. The next parameter that needs to be calibrated is τ_r. This is determined by the social security replacement ratio which gives a retirement tax rate 0.0765.

Parameters corrsponding to the bond increment size, γ, and the transactions costs, tc, associated with stocks must also be specified. We calibrated γ to the ratio of a \$10,000 bond to average income. In the results section, we examine the importance of this specification for the results. The transaction coefficient is set to 0.025. This is the parameter employed in Aiyagari and Gertler(1991).

The specification of the stochastic idiosyncratic labor productivity process is extremely important because of the implications that this choice has for the eventual distribution of wealth. Often (the log of)labor productivity is assumed to be generated by a simple autoregressive process. For example, Heaton and Lucas (1996) estimate the autoregressive parameter in an individual labor productivity equation to be 0.529. Storesletten, Telmer and Yaron (2001) argue that the specification of labor income or productivity process for an individual household must allow for permanent and transitory components. Based on their empirical work, specify $u_{it} = \ln(\xi_{it})$ to be:

$$u_{it} = \omega_{it} + \epsilon_{it}$$

$$\omega_{it} = \rho\omega_{it-1} + v_{it}$$

where $\epsilon_{it}\tilde{} N(0, \sigma_\epsilon^2)$ is the temporary component and ω_{it} is the permanent component. The innovation term associated with this component is assumed to $v_{it}\tilde{} N(0, \sigma_v^2)$. They estimate $\rho = 0.935$, $\sigma_\epsilon^2 = 0.01$, and $\sigma_v^2 = 0.061$. Fernández-Villaverde and Krueger (2000) approximate the Storesletten, Telmer and Yaron process with a three state Markov chain. They specify the productivity value at the lowest state to be 0.5 while the productivity value at the middle and highest states to be 0.93 and 1.51, respectively. The transition matrix is:

$$\pi = \begin{bmatrix} 0.75 & 0.24 & 0.01 \\ 0.19 & 0.62 & 0.19 \\ 0.01 & 0.24 & 0.75 \end{bmatrix}$$

The invariant distribution associated with this transition matrix implies that an individual will be in the low or the high productivity state 31 percent of the time. An individual will be in the middle or average productivity state 38 percent of the time. We employ this transition probability matrix in our baseline model.

4.2 Computational Issues

The solution to the models requires numerical methods. We will briefly discuss the algorithm we employ to solve our dynamic general equilibrium model. We solve the household dynamic programming problem by setting up a grid on the state variables m, b, k, age, and employment state for each working age individual and a grid on m, b, k, and age for each retired individual. Over the state, we use the finest grid on money holdings. The monetary authority chooses a money growth rate, (i.e., inflation rate). We then supply a guess on the market clearing stock return, bond price, price level, and income tax rate. Given these values, we solve for the household's optimal decision rules by using backward recursion to find the household's value function. Using these decision rules and the transition matrix for employment, we calculate the invariant measure of households across the state space. Once we have the distribution of households over the state space, the aggregate level of money, bonds, stocks, and accidental bequests can be calculated by summing over this invariant distribution of households. Given the aggregate level of money, bond, stock holdings, and accidental bequests, we check to see whether all markets have cleared and accidental bequests are identical with the initialized value. If any of the markets are not cleared (or if accidental bequests differ from initial value) we update the prices using a bisection approach. Using these values, we resolve the problem. We iterate on this vector of prices until convergence is achieved.

5 Empirical Results

5.1 Evaluation of the Baseline Model

We begin by examining the characteristics of the economy generated by the baseline model. We define the baseline economy as an economy with a four percent inflation rate. Table 4 presents the equilibrium return on stocks, the discount price of bonds, the aggregate price level, and the income tax rate required for the government budget constraint to hold. The equilibrium (net) rate of return on stocks in this model is 7.0 percent. This return is slightly less than what is actually observed. This can be partially explained by the absence of aggregate uncertainty in stocks. The equilibrium price of the government bond is 0.977. This translates to a risk-free rate of return equal to 2.4 percent. At a four percent inflation rate, the equilibrium price level is 0.797. The last variable that is solved for is the tax rate on wage and capital income. Given the assumed inflation rate, we find the balanced budget tax rate on income is 30 percent.

The model can be used to generate the implied life-cycle portfolio implications for our model economy. Figure 4 presents the results for the baseline model from two perspectives. The upper panel presents average asset holdings in units of the consumption good over the life-cycle. In the data section, we identified the fact an individual's level of stockholding increases with age until around the retirement age. After retirement, the level of stockholding declines. In other words, stocks seem to have a humped-shaped holding pattern over the life-cycle. Our model generates such a pattern, although the level of stockholding appears to be too large relative to the other assets.

We found that the average value of bond holdings increased until the 45-54 cohort and then stay approximately at the same level for the 45-54 and 55-64 cohorts. Eventually, bond holdings gradually declines over the retired cohorts. The empirical data display similar patterns. The main differences between the empirical and modelled bond holdings is that the peak for bond holding is earlier in the data. This can be partly explained by the lack of bequests in the model. Many young adults receive savings and other types of bonds from their parents. Our data sample suggests that the level of bond holding on average is less than either stock holding or money holding. Again, the model generates these relative holding levels as are found in the data.

The final asset we want to examine is liquid asset holdings. Data indicates that the level of liquid assets increase with age cohorts up to the 65-74 cohort. After that age, liquid asset holdings decline. The model generates an increase in money holdings up to the retirement age. We find that money holding temporary decrease around retirement and then increase around age 70. It seems that agents react to the change from being a worker to a retiree by temporarily reducing total money holdings. After age 70, the agents decrease money holding. Such behavior is also found in the data.

It is also interesting to examine whether households hold money balances for reasons other a transactions motive. To analyze this, we also plot consumption spending and money holding over the life-cycle. We find the model generates a humped-shaped consumption pattern that has been documented in Deaton (1991). As can be seen, the level of money holding at each age exceed consumption at that same age. This suggests that some money balances are held for precautionary purposes. When a household retires, we find a drop in the level of precautionary holdings. The behavior is explained by the fact that the uncertainty associated with labor income is no longer present which reduces the need for precautionary cash balances.

The lower panel in Table 4 examines the predictions of the model on the relative shares of the various assets in the household's portfolio over the life-cycle. Data indicates that money holding seem to be characterized by a U-shaped pattern. Both the very young and relatively old seem to skew their portfolios toward the holding of money. Money holding in our economy displays similar behavior. Younger individuals tend to have low income levels making stock holding difficult due to transactions costs and bond holding nearly impossible due to the relatively large denomination size of the bonds. In addition, money holding dominates the financial portfolio due to the cash-in-advance constraint. Older individuals hold money because of the strong consumption smoothing motive and a weak saving motive. According to the model, the fraction of the financial portfolio allocated to stocks has a relatively flat inverted humped shaped pattern. Between age 40 and age 65, approximately 70 percent of the portfolio is held in stocks. Compared to actual data which suggests that stocks account for approximately 45 percent of the portfolio, the model generates too much stock holding. This result is not surprising. Stocks in our model face no aggregate uncertainty which would tend to decrease stock holding. Bond holding in the data seems to gradually decline with age. This is a somewhat surprising result given the conventional wisdom that older individuals should be holding more bonds.[12] The model does not generate such a pattern. Rather, a humped shaped pattern in bond holdings is generated. More importantly, the level of bond holdings generated in the model is too low for young households. As mentioned earlier the low bond holdings by young households could be explained by the lack of bequests which often take the form as bonds. Once a household is middle-aged the share of bond holding in the model and in the data is close. To summarize, we find that even given a few shortcomings, the model does a reasonable job of matching the relative shares found in empirical portfolio data.

[12] See Canner, Mankiw, and Weil(1997).

5.2 Some Robustness Results with Respect to Parameters

A reasonable question is whether the aforementioned results are heavily dependent on the specification of the transaction cost parameter or the bond size parameter. In order to address this issue we considered alternative parameterizations. We examined alternative values for the transaction cost coefficients which ranged from one percent to five percent. In general, the findings with respect to the allocation of assets in the portfolio over age did not significantly change. The primary impact of an increase in transaction costs is slightly delay the movement into and out of stock. Households hold slightly more stock at their earnings peak. This is consistent with the increase in the steady state difference in the stock return-bond return spread.

Another concern is whether the denomination of the bond drives our findings. In order to investigate this possibility, we examine various lower denomination values. Just as with the analysis of the transation cost parameter, we find these general conclusion remain the same. As we lower the denomination value, individuals get into bond positions earlier and stay in bonds longer. This reallocation comes primarily from money holdings. However, we must stress that these changes are an order of magnitude that is too small to matter.[13] Given that the model does a good job at matching household portfolios, we address the portfolio effects of changes in the rate of anticipated inflation.

5.3 Some Robustness Results with Repect to Inflation

In this section, we examine the results of the model across different inflation rates: -2%. 0%, 2%, 8% and 12%. For all of these rates, the asset holding patterns were similar to those shown for the baseline model. The baseline portfolio patterns are robust to the different inflation rates. Thus, prior results in general hold for asset levels as well as for portfolio shares.

Figure 3 presents the average portfolio for households under 0%, 4%, and 12% anticipated inflation. We find the bond holding seems to be unaffected by anticipated inflation. Most of the portfolio effects occur in the substitution between money and stock holdings. Specifically, we find that in a higher inflation regime, households seems switch out of the liquid asset, and into

[13]Detailed results are available from the authors upon request.

stocks as an individual attempts to avoid the depreciation of money. This portfolio adjustment is particularly strong for households between ages 45 and 65. This suggests that inflation may have important implications for retirement positions. Figure 4 displays the same result when we look at portfolio shares. In a world of 0% inflation, the average 60 year old household would hold 20% of their portfolio in liquid assets and 72% in stocks. When inflation increases to 12% these shares change to 15% in money and 79% in stocks. This is a sizable portfolio reallocation especially when we consider that these are the wealthiest households. Wealthier households are able to mitigate the effects of inflation by adjusting their financial portfolios. Poorer households may wish to avoid the costs of higher inflation, but the lack flexibilty in asset choice of doing so. This effect is particularly strong for young households who are unlikely to have had an opportunity to accumulate a diversified portfolio.

This portfolio reallocation has implications which we can observe at the aggregate level. We find that equilibrium asset prices change significantly with inflation. Table 4 displays the equilibrium prices across the range of inflation rates. We find that as inflation increases, the return on stocks fall, the discount price on bonds rises, and the equilibrium tax rate increases. When an individual knows inflation is going to be higher, they attempt to convert money holdings into either bond or stock holding. This behavior results in an increase in the price of bonds. Individuals desire to increase capital (stock) holdings leads to an increase in capital available to firms. This results in a decline in the equilibrium marginal productivity of capital, or equivalently the rate of return on capital. The fact that inflation allows for lower tax rates follows from the government budget constraint. Given a level of government spending, higher anticipated inflation rates result in an increase in seinorage and income tax revenue. This means a lower tax rate will generate required revenue to financed the given expenditure level. Since the price of bonds increases with inflation, an inverse relationship exists between the risk-free interest rate and inflation. Table 5 displays this result. An inverse relationship between the risk-free rate, and inflation has been previously posited by Lucas (2000), Tobin (1965), and Mundell (1963). Mundell and Tobin argued that inflation could lower the real interest rate permanently as wealth holders rebalance portfolios away from money and reduce consumption. This is commonly known as the Mundell-Tobin effect. This model generates something similar to this effect. The difference is that the rebalancing of the portfolios does not necessary imply a reduction in consumption. This is shown in Table 6 which presents the aggregates of the economy under different inflation rates. We find that as the inflation rate increases, the aggregate stock holding increases, and the aggregate money holding decreases. We also find that aggregate consumption increases with inflation. The existence of precautionary money holding allows households to switch away from liquid assets and increase consumption under higher inflation. Only under a situation of excessive inflation would households exhaust precautionary money holdings and have to decrease consumption.

5.4 Conclusions

In this paper we study household financial portfolios and the effects of anticipated inflation on these portfolios. Using an overlapping generation dynamic general equilibrium model, we find that we can reasonably replicate the observed life-cycle portfolio patterns. Agents in this economy begin with no assets, and accumulate assets throughout their working years. They consume all of their assets during retirement. Money holdings follow a "U-shaped" pattern as a proportion of the total portfolio over the life-cycle. Stock holdings follow a humped pattern over the life-cycle. We find substantial consumption smoothing over the life-cycle, with money holdings consistently following this pattern. The model reasonably match empirical portfolios, particularly when looking at portfolio shares over the life cycle.

Given that our model does a reasonable job of matching empirical financial portfolios, we address the portfolio effects of anticipated inflation. After computing the model across a range of inflation rates, we find the following results. Increased inflation has modest effects on household portfolios. As inflation increases, households decrease money holdings, and increase stock holdings. These effects are particularly strong for households between ages 45 and 65. This pattern is robust to aggregate asset levels as well as portfolio shares. Bond holdings are hardly affected by increased inflation. These portfolio effects can be translated into aggregate effects. Aggregate stock holdings and consumption increase with higher inflation. Since the rate of return on money falls with increased inflation, we also find that aggregate money holdings fall with inflation. Given that consumption and money holdings move in opposite directions, precautionary money holding falls significantly as inflation rises. We also find significant changes in aggregate prices at different levels of anticipated inflation. We find that as the rate of inflation increases, the rate of return on stocks falls, the discount price of bonds rises, the price level on goods increases, and the government budget balancing income tax rate decreases. The increase in the price of the discount bonds implies that the risk-free interest rate and the level of anticipated inflation are inversely related. Thus the model confirms the Tobin effect.

It is important to note that this paper does not directly address the issue of the welfare costs of inflation. Although this model appears to be a perfect tool for addressing this issue, the size of the model makes computing the welfare costs of inflation infeasible. To correctly measure the welfare costs of inflation, we would need to compute the transitional dynamics of this economy. This would require us to store the entire economy for 50 to 100 periods thus creating a state space which cannot be stored using current technology. However, given the modest portfolio effects that we find, we can argue that, as with most of the existing literature, the welfare costs of anticipated inflation are reasonably small.

The obvious extension for this paper would be to move to an economy that experiences unanticipated inflation. One reason for the low welfare costs of inflation is because the agents can see the change in the inflation rate. As a result, agents adjust their portfolios in an attempt to mitigate the costs of higher inflation. In a world of unanticipated inflation, this would not be the case. Agents would no longer be able to insure against changes in the money growth rate. This would lead to misallocations in household portfolios, and should lead to higher welfare costs of inflation. Not only should unanticipated inflation affect the aggregate welfare costs of inflation, but it should have implications for the life-cycle costs of inflation. The older agents would no longer have the ability to use perfect foresight to eliminate all the portfolio effects of inflation. They now face inflation uncertainty, and we would expect higher welfare costs of inflation for the older population.

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6 Appendix: Computational Method

We discretize the state space by choosing a finite grid over money, bond, and capital holdings. We restrict optimal choices to lie on the grid. The joint measure over the various assets, labor productivity, and age, Λ, can then be represented as a finite-dimensional array. After making the economy stationary by transforming for population growth, the structure of the algorithm used to compute the equilibrium is as follows:

To compute the steady state for a particular money growth rate,

1. Choose the target inflation rate, e.

2. Guess r, q, tr, P, τ_y, Λ and compute K, and w. N is determined by the invariant age-distribution Π. Once the aggregate labor input is determined, τ_r be calculated.

3. Solve backward for value and policy functions using $V(\cdot,\cdot,\cdot,\cdot,J{+}1) \equiv 0$.

4. Use decision rules to compute new r, q, tr, P, τ_y and Λ.

5. Update r, q, tr, P, τ_y and Λ.

6. Iterate on r, q, tr, P, τ_y and Λ until convergence.

Table 1
Portfolio Allocations By Wealth Distribution
(1994 Wealth Supplement to PSID)

Wealth Quartile	Average Age	Average Holding of Wealth	Cash	Bonds	Stocks	Percent of Financial Wealth in Cash	Bonds	Stocks
1*st*	41	8,049	2,304	567	372	70.95	17.62	11.41
2*nd*	45	40,044	6,672	2,616	2,771	55.47	21.59	22.92
3*rd*	46	96,668	14,262	6,103	9,213	48.35	20.58	31.03
4*th*	51	433,408	60,987	32,616	80,914	34.98	18.61	46.39
Total	46	144,542	21,056	10,475	23,317	52.39	19.54	28.03

Table 2
Portfolio Allocations From an Age Cohort Perspective
(1994 Wealth Supplement to PSID)

		Average Holdings			% of Financial Wealth		
Age Cohort	Wealth	Cash	Bonds	Stocks	Cash	Bonds	Stocks
18-24	27,717	5,791	6,569	975	65.49	30.03	4.45
25-34	44,912	7,327	10,685	4,758	48.93	35.37	15.75
35-44	81,763	13,362	10,052	21,034	39.83	19.46	40.69
45-54	150,228	21,371	13,666	28,381	39.81	19.55	40.62
55-64	164,967	30,025	13,650	44,515	38.87	14.35	46.79
65-74	160,085	35,630	9,836	50,705	42.76	9.29	47.93
75 plus	115,003	35,017	4,083	27,040	61.87	4.99	33.10

Table 3

Parameters for the Baseline Model

	Parameter	Parameter Value
Demographic:		
Initial Age		21
Terminal Age	J	85
Retirement Age	j^*	65
Conditional Survival Rates	$\{\psi_j\}$	Farber (1982)
Age-Earning Profile	$\{\varepsilon_j\}$	Current Population Reports (1991)
Technology:		
Labor Share	$(1-\alpha)$	0.67
Depreciation Rate	δ	0.05
Transaction Cost on Stocks	tc	0.025
Bond Denomination Size	γ	0.25
Preferences:		
Discount Factor	β	0.995
Coefficient of Risk Aversion	σ	1.5
Stochastic Labor Variables:		
Indiosyncratic Productivity	ξ	$\begin{bmatrix} 0.50 & 0.93 & 1.51 \end{bmatrix}$
Transition Matrix	π	$\begin{bmatrix} .75 & .24 & .01 \\ .19 & .62 & .19 \\ .01 & .24 & .75 \end{bmatrix}$
Invariant Distribution	Π	$\begin{bmatrix} .31 & .38 & .31 \end{bmatrix}$
Government Variables:		
Government Consumption	G	0.31
Government Debt	D	0.42

Table 4

Aggregate Prices vs Inflation

Inflation Rate	Net Stock Return	Bond Price	Price Level	Inc. Tax Rate
−2%	0.079	0.932	0.713	0.410
0%	0.074	0.949	0.745	0.371
2%	0.071	0.958	0.786	0.339
4%	0.070	0.977	0.797	0.303
8%	0.065	0.985	0.836	0.248
12%	0.063	0.996	0.845	0.191

Table 5

Risk Free Rate vs Inflation

Inflation Rate	Risk Free Rate
−2%	7.350%
0%	5.346%
2%	4.439%
4%	2.407%
8%	1.520%
12%	0.357%

Table 6

Aggregate Variables and Inflation

Inflation Rate	Capital	Bonds	Money	Consumption
−2%	3.778	0.42	1.404	0.578
0%	4.040	0.42	1.338	0.597
2%	4.134	0.42	1.273	0.606
4%	4.167	0.42	1.212	0.627
8%	4.521	0.42	1.189	0.641
12%	4.654	0.42	1.187	0.670

Figure 1: Asset Holdings as a Percentage of Household Portfolios

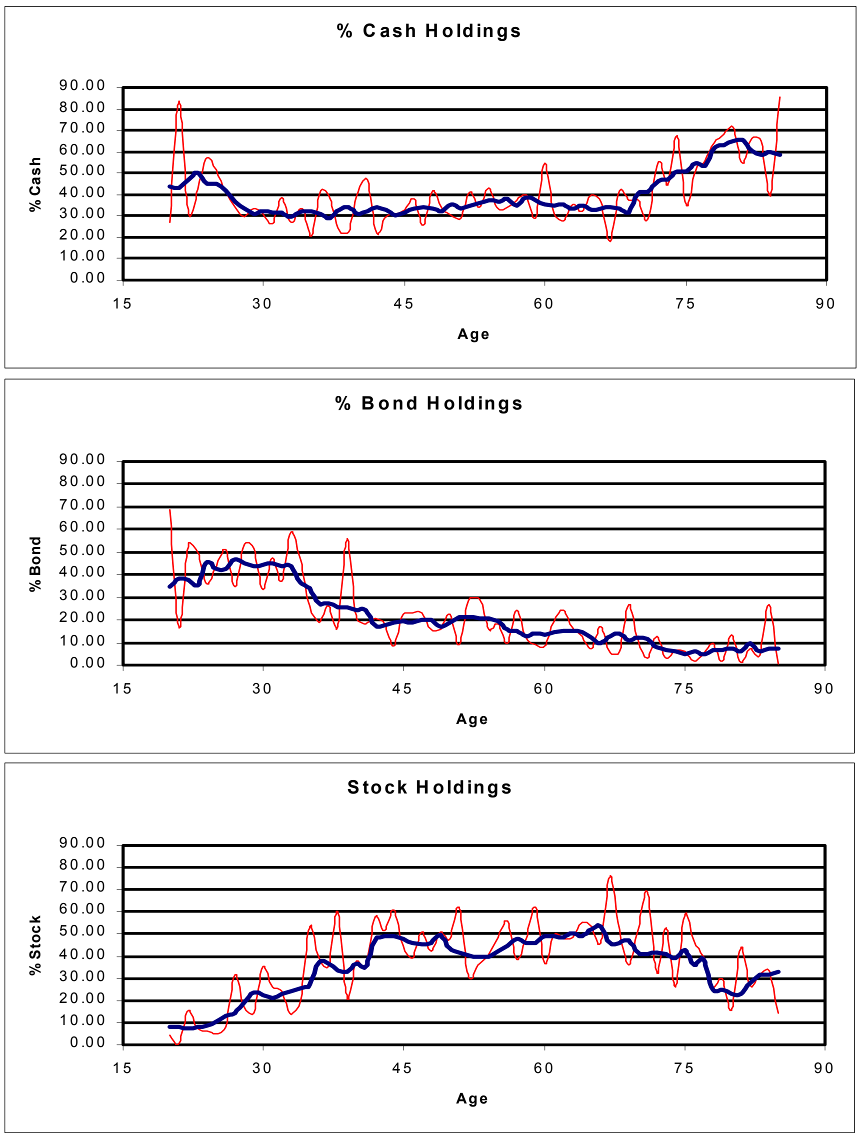
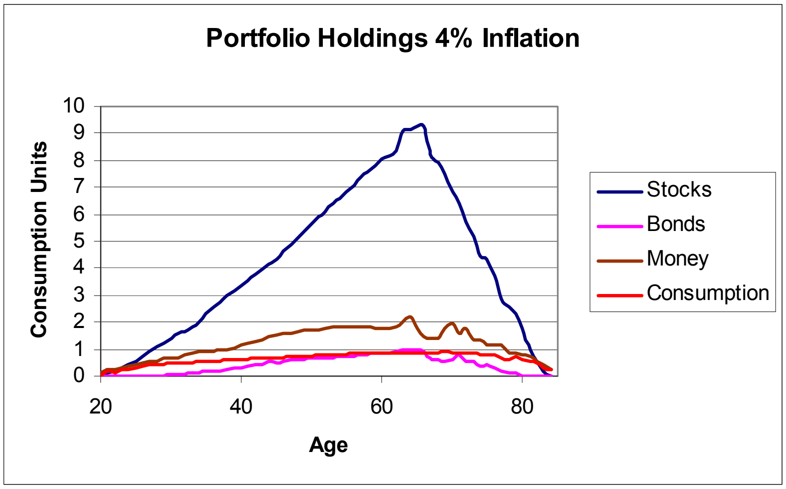


Figure 2: Baseline Results



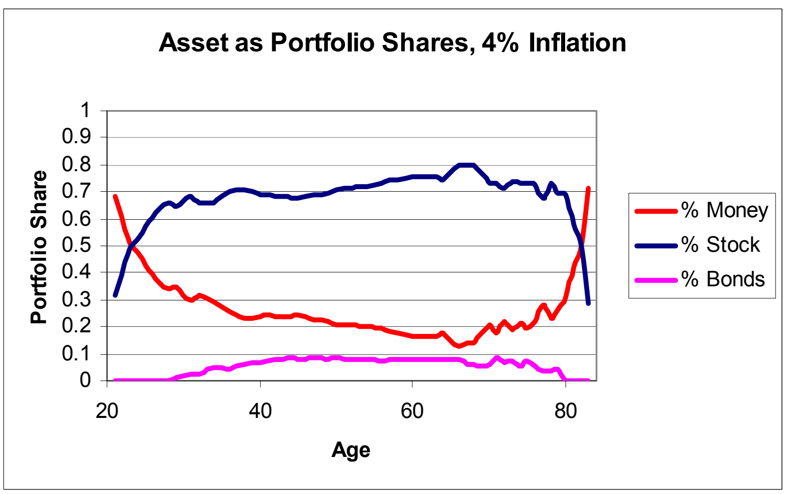


Figure 3: Asset Holdings vs Inflation

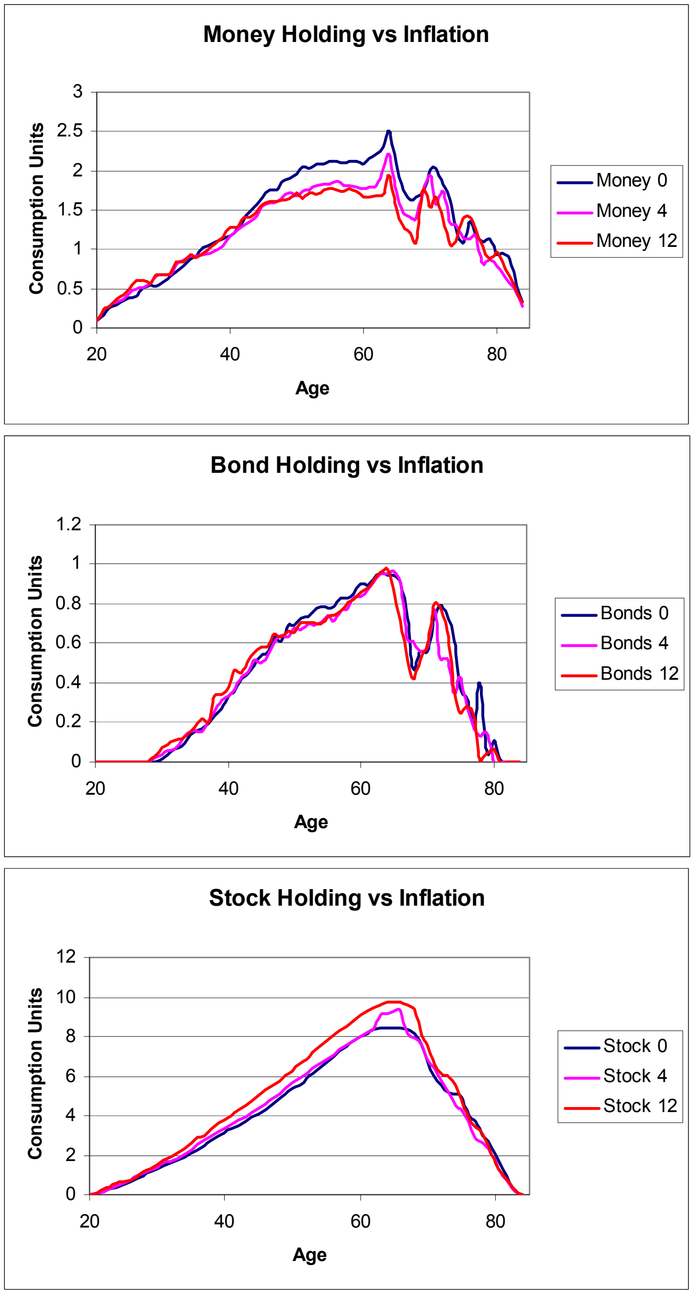


Figure 4: Portfolio Shares vs Inflation