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Understanding Why High Income Households Save More Than Low Income Households

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ABSTRACT

This paper investigates why high income households in the United States save on average more than low income households in cross-section data. The three explanations considered are (1) age differences across households, (2) temporary earnings shocks, and (3) the structure of transfer payments. We use a calibrated life-cycle model to evaluate the quantitative importance of these explanations and find that age and the structure of transfers are quantitatively important in producing the cross-section pattern of United States savings rates. Temporary shocks are of secondary importance.

1 Introduction

One of the stylized facts of US savings behavior documented in cross-sectional household surveys is that high income households save on average a higher fraction of income than do low income households. The differences in average savings rates at different multiples of mean income are striking. Figure 1 shows that households with income levels below one half of mean income in the economy dissave, whereas households with income levels of three or more times mean income save in excess of 20 percent of income. One implication of this fact is that savings must be very concentrated within the upper tail of the income distribution.[1]

[Insert Figure 1 Here]

What explains this savings observation? It is clear that any explanation will involve two steps: aggregating the savings behavior of heterogeneous households and accounting for the heterogeneity in savings rates across households. To understand savings rate heterogeneity across households it is important to focus on how households differ. Our strategy is to consider only a few ways in which households differ. In particular, we focus on differences across households in age and earnings history while abstracting from preference heterogeneity and all other shocks except earnings shocks. We then examine the resulting savings behavior when some key features of market structure and institutional arrangements are modeled. These key features are the lack of markets for insuring earnings uncertainty and the presence of a social security system with features similar to the current US system.

This framework allows us to examine a number of different ways in which average savings rates could differ at different income multiples. First, age could be key as households with high income are more likely to be in the middle of the life cycle and therefore saving at a high rate for retirement. Second, earnings shocks could be important. In particular, temporary earnings shocks will be largely saved if positive and dissaved if negative. Thus, savings rates of high income households are likely to be higher than low income households in the same age group as the households with high income will have a disproportionate fraction experiencing positive shocks and the op-

[1] In particular, the distribution of savings must be more concentrated than the distribution of income. To get a rough idea of the degree of concentration, consider the work of Smith and Frechtling (1951). They calculate that the top 10 percent of the income distribution accounted for between 73 and 105 percent of net savings in the years 1947-50.

posite pattern for those with low income. Third, the tax and transfer system could be important. One key feature of current social security arrangements is that benefits are not proportional to contributions. Thus, households with permanently high earnings levels will save at higher rates before retirement than will households in the same age group with permanently lower earnings levels as benefits are of minor importance to very high earners but a substantial source of retirement income and health benefits to low earners. In this way the distributional effects of transfer arrangements could also lead to differences in measured savings rates within age groups.

The main findings of the paper are that calibrated life-cycle economies with the features described above imply the type of savings behavior that is observed. The key features of the model economies that produce this savings behavior are the age structure, the structure of social security transfers and the presence of largely permanent differences in earnings across households. We find that neither preference heterogeneity nor a specific pattern of earnings shocks are essential in producing this result. The fact that temporary earnings shocks have only a modest contribution to decreasing the savings rate at low incomes and increasing the savings rate at high incomes is a surprising finding of this investigation.

This paper is organized in six sections. Section 2 documents the stylized fact discussed in the introduction. Section 3 describes the model economies we investigate. Section 4 describes how we parameterize the model economies to be realistic descriptions of the US economy along some dimensions. Section 5 analyzes the savings-income ratios produced in the US economy and in the model economies. Section 6 concludes.

2 Savings-Income Ratios in the US

We briefly review some of the evidence on the cross-section relationship between the savings-income ratio and the level of income in the US. This relationship has been documented in numerous studies including Brady and Friedman (1950), Fisher (1952), Kuznets (1953), Friend and Schor (1959), Projector (1968), Avery and Kennickell (1991) and Bosworth et al (1991). These studies construct measures of household income and net savings from cross-sectional household surveys. The results of these studies show that average household savings rates tend to increase as household income increases.

Table 1
Savings Rates at Multiples of Mean Income: US 1929-1950

Income Multiple	1929	1935	1941	1942	1945	1946	1947	1948	1949	1950
.25	-30.4	-32.1	-15.6	-25.1	4.9	-9.3	-14.8	-22.2	-31.1	-15.9
.50	-1.3	-7.4	0.2	-0.1	7.9	1.9	1.4	-1.3	-5.7	-0.8
.75	8.1	-1.5	5.3	8.3	10.7	7.0	4.6	3.2	-0.6	3.9
1.0	11.6	3.5	5.0	10.9	12.9	10.8	7.0	6.4	5.0	7.4
1.5	16.3	9.4	10.7	15.9	15.7	15.9	10.2	10.8	11.2	12.1
2.0	19.5	14.1	13.9	18.2	19.6	19.7	14.0	14.0	15.6	15.4
3.0	23.6	21.9	19.3	22.7	28.6	24.9	21.5	18.5	21.8	20.2
4.0	29.0	27.2	24.8	27.2						
7.0	37.0	37.5								
10.0	38.5	39.8								
25.0	43.1	49.2								

Source: Kuznets (1953, Table 48)

Consider the results obtained by Kuznets (1953). He reports annual savings as a fraction of income for households at various multiples of mean income. The data come from various surveys conducted between 1929 and 1950. The results of his analysis are presented in Table 1. The averages of these data were previously displayed in Figure 1. We observe that the savings-income ratios are typically negative for households with income levels below one-half of mean income. The ratio increases nearly monotonically as the multiple of mean income increases. For households with income multiples of three or more times mean income the average savings rate exceeds 20 percent. It is interesting to note that these patterns occur in the individual years examined and therefore the pattern in Figure 1 is not the result of time averaging the data.

It is interesting to compare the savings rates at different income multiples found by Kuznets to those in more recent data. Projector (1968, Table 4) presents results from several surveys in the 1960's. Projector also finds that savings rates tend to increase with the multiple of mean income. As Figure 1 shows, the findings are quantitatively similar to those in the Kuznets study. Note that Projector does not have data for income multiples of 4.0 or higher. Bosworth et al (1991, Table 5) present evidence from surveys in the 1960's, 1970's and the 1980's. They find that average household savings rates tend to increase with income. Furthermore, their results show that even though savings rates have tended to decline for all income groups since the 1960's there continue to be large differences in average savings rates across different income groups.

3 The Economies Investigated

3.1 The Environment

We consider an overlapping generations economy.[2] Each period a continuum of agents are born. Agents live a maximum of N periods and face a probability s_j of surviving up to age j conditional on surviving up to age j-1. The population grows at a constant rate n. These demographic patterns are stable so that age j agents make up a constant fraction μ_j of the population at any point in time.[3] All age 1 agents have identical preferences over consumption:

$$E\left[\sum_{j=1}^{N} \beta^j (\prod_{i=1}^{j} s_i) u\left(c_j\right)\right]$$

The period utility function $u(c)$ is of the constant relative risk aversion class, where σ is the coefficient of relative risk aversion.

$$u(c) = c^{(1-\sigma)}/(1-\sigma)$$

An agent's labor endowment is given by a function $e(z,j)$ that depends on the agent's age j and on an idiosyncratic labor productivity shock z. The shock z lies in a set Z and follows a Markov process. Labor productivity shocks are independent across agents. This implies that there is no uncertainty over the aggregate labor endowment even though there is uncertainty at the individual agent level. The function $e(z,j)$ is described in detail in section 3.

At any time period t there is a constant returns to scale production technology that converts capital K and labor L into output Y. The technology improves over time because of labor augmenting technological change. The technology level X_t grows at a constant rate, $X_{t+1} = (1+g)X_t$. Each period capital depreciates at rate δ.

$$Y = F(K, LX) = AK^{\alpha}(LX)^{1-\alpha}$$

[2]The modeling framework used here is similar to that used by Imrohoroglu et al (1995) and Huggett (1995).

[3]The weights μ_j are normalized to sum to 1, where $\mu_{j+1} = (s_{j+1}/(1+n))\mu_j$.

3.2 The Arrangement

We consider an arrangement where in each period t an age j agent with idiosyncratic shock z chooses consumption c_t and risk-free asset holdings a_{t+1}. The period budget restriction for such an agent is then

$$c_t + a_{t+1} \leq a_t(1 + r_t(1-\tau)) + (1-\theta-\tau)e(z,j)w_t + T_t + b_{j,t}$$
$$c_t \geq 0,\ a_{t+1} \geq \underline{a_t} \text{ and } a_{t+1} \geq 0 \text{ if } j = N$$

In the above budget constraint resources are derived from asset holdings a_t, labor endowment $e(z,j)$, a lump-sum transfer T_t and an age-dependent social security benefit $b_{j,t}$. Assets pay a risk-free return r_t and labor receives a real wage w_t. Agents are allowed to borrow up to a credit limit $\underline{a_t}$ in period t. In addition, if an agent survives up to the terminal period ($j = N$), then asset holdings must be nonnegative.

There are income and social security taxes in the model economies. Capital and labor income are taxed at the income tax rate τ. Labor income is also subject to a social security tax θ. The social security benefit $b_{j,t}$ is zero before the retirement age R and equals a fixed benefit level for an agent after retirement.[4] All agents of the same age receive the same retirement benefit as there is no linkage between a specific agent's earnings and future social security benefits.

The assumption that benefits are independent of earnings history is a strong assumption. We make it for two reasons. First, it simplifies the agent's decision problem significantly. With this assumption only an agent's last earnings, and not the entire earnings history or an average of past earnings, need be a state variable in the agent's decision problem. Second, it is a rough approximation to the highly redistributive nature of the actual link between earnings and retirement benefits. Hospital insurance (HI) benefits to retirees in the US Social Security system are independent of earnings history. Thus, it is a factually correct assumption for this component of benefits. Old-age and survivors insurance (OASI) benefits are linked to earnings history. However, this link is a highly redistributive one. The monthly benefit is related to a retiree's average indexed monthly earnings (AIME). In 1992, benefits are 90 percent of the first \$ 401 of AIME, 32 percent of the next \$ 2,019 of AIME

[4] The benefit level grows over time at the rate of technological change. Thus, cohorts that retire later receive a higher benefit level.

plus 15 percent of AIME over \$ 2,420. In addition, there are minimum and maximum benefit levels that make benefits even more redistributive than these rules suggest.[5]

For computational purposes we transform variables so as to remove the effects of growth. These transformations are as follows:

$$\hat{a}_t = a_t/X_t, \hat{c}_t = c_t/X_t, \hat{T}_t = T_t/X_t, \hat{b}_{j,t} = b_{j,t}/X_t, \underline{\hat{a}_t} = \underline{a_t}/X_t$$
$$\hat{K}_t = K_t/L_tX_t, \hat{L}_t = L_t/L_t, \hat{G}_t = G_t/X_tL_t, \hat{w}_t = w_t/X_t, \hat{r}_t = r_t$$

With these transformations in mind we now describe an agent's decision problem in the language of dynamic programming. At a point in time an agent's state is denoted $x = (\hat{a}, z)$, where $\hat{a}$ is (transformed) asset holdings carried into the period and z is the labor endowment shock.[6] Optimal decision rules are functions for consumption $c(x, j)$ and asset holdings $a(x, j)$ that solve the following dynamic programming problem, given that after the terminal period N the value function is set to zero, $V(x, N+1) = 0$.

$$V(x,j) = Max_{(\hat{c},\hat{a}')} u(\hat{c}) + \beta(1+g)^{(1-\sigma)} s_{j+1} E[V(\hat{a}', z', j+1)|x]$$

subject to

$(1)\hat{c} + \hat{a}'(1+g) \leq \hat{a}(1+\hat{r}(1-\tau)) + (1-\tau-\theta)e(z,j)\hat{w} + \hat{T} + \hat{b}_j$
$(2)\hat{c} \geq 0, \hat{a}' \geq \underline{\hat{a}}$ and $\hat{a}' \geq 0$ if $j = N$

Note that the period budget constraint in the dynamic programming problem is essentially the same as the budget constraint written in terms of untransformed variables. The key differences are that time subscripts are dropped and a term $(1+g)$ is added. Time subscripts are dropped as we focus on steady-state equilibria where transformed factor prices are constant over time. The additional term $(1+g)$ appears due to the transformation of variables. Finally, note that the credit limit $\underline{\hat{a}}$ appears without a time subscript. This is because we focus on credit limits that are always proportional to the current wage rate.

[5]See the Annual Statistical Supplement of the Social Security Bulletin for complete details.

[6]Note that we do not include time t as a state variable. This is because the transformation above together with the focus on steady-state equilibria make an agent's problem time invariant.

3.3 Equilibrium

To state the equilibrium concept, some way of describing heterogeneity in the economy at a point in time is needed.[7] At a point in time agents are heterogeneous in their age j and their individual state x. A probability measure ψ_j defined on subsets of the individual state space will describe the distribution of individual states across age j agents. So let $(X,\ B(X),\ \psi_j)$ be a probability space where $X = [\underline{\hat{a}}, \infty) \times Z$ is the state space and $B(X)$ is the Borel σ-algebra on X. Thus, for each set B in $B(X)$, $\psi_j(B)$ is the fraction of age j agents whose individual states lie in B as a proportion of all age j agents. These agents then make up a fraction $\mu_j\psi_j(B)$ of all agents in the economy, where μ_j is the fraction of age j agents in the economy. The distribution of individual states across age 1 agents is determined by the exogenous initial distribution of labor productivity shocks since all agents start out with no assets. The distribution of individual states across age $j = 2, 3, ..., N$ agents is then given recursively as follows:

$$\psi_j(B) = \int_X P(x, j-1, B) d\psi_{j-1}$$

The function $P(x, j, B)$ is a transition function which gives the probability that an age j agent transits to the set B next period, given that the agent's current state is x. The transition function is determined by the optimal decision rule on asset holding and by the exogenous transition probabilities on the labor productivity shock z.[8]

We focus on steady-state equilibria. In a steady state the transformed capital and labor inputs, transfers and government consumption are constant over time. Thus, without the transformation these variables all grow at constant rates. In steady state the age-wealth distribution is stationary or unchanged over time when stated in terms of transformed variables.

Definition: A steady-state equilibrium is ($c(x,j)$,$a(x,j)$,$\hat{w}$,$\hat{r}$,$\hat{K}$,$\hat{L}$,$\hat{G}$,$\hat{T}$,$\hat{b}$,θ,τ) and distributions $(\psi_1, \psi_2, ..., \psi_N)$ such that

1. $c(x, j)$ and $a(x, j)$ are optimal decision rules.

[7] See Laitner (1992), Aiyagari (1994) and Rios-Rull (1995) for a discussion of heterogeneous-agent models that have a similar structure to the one investigated here.

[8] The transition function is $P(x, j, B) = \text{Prob}(z' : (a(x, j), z') \in B | z)$, where the relevant probability is the conditional probability that describes the behavior of the Markov process z.

2. Competitive Input Markets: $\hat{w} = F_2(\hat{K}, \hat{L})$ and $\hat{r} = F_1(\hat{K}, \hat{L}) - \delta$
3. Markets Clear:
   $(i) \sum_j \mu_j \int_X (c(x,j) + a(x,j)(1+g))d\psi_j + \hat{G} = F(\hat{K}, \hat{L}) + (1-\delta)\hat{K}$
   $(ii) \sum_j \mu_j \int_X a(x,j)d\psi_j = (1+n)\hat{K}$
   $(iii) \sum_j \mu_j \int_X e(z,j)d\psi_j = \hat{L} = 1$
4. Distributions are Consistent with Individual Behavior:
   $\psi_{j+1}(B) = \int_X P(x,j,B)d\psi_j$ for $j = 1, ..., N-1$ and for all $B \in B(X)$.
5. Government Budget Constraint: $\hat{G} = \tau(\hat{r}\hat{K} + \hat{w}\hat{L})$
6. Social Security Benefits Equal Taxes: $\theta\hat{w}\hat{L} = \sum_{j=R}^{N} \mu_j \hat{b}_j$
7. Transfers Equal Accidental Bequests:
   $\hat{T} = [\sum_j \mu_j (1 - s_{j+1}) \int_X a(x,j)(1 + \hat{r}(1-\tau))d\psi_j]/(1+n)$

A brief discussion of the equilibrium concept is in order. Equilibrium condition 1 says that agents optimize. Condition 2 says that factor prices equal marginal products. The first market clearing condition is that aggregate consumption, asset holding and government consumption equals the current output plus the capital stock after depreciation. Note that the term $(1+g)$ appears in this expression so that next period asset holdings are corrected for next periods technology level. The other market clearing conditions are that asset holdings are sufficient to keep the capital stock constant after adjusting for population growth and technological change and that the labor input per capita is equal to 1. Equilibrium conditions 5 and 6 say that income taxes collected are sufficient to pay for government consumption and that social security taxes are sufficient to cover the benefits paid to agents who are past the retirement age. In this formulation social security is funded on a pay-as-you-go basis. The remaining equilibrium condition is that lump-sum transfers equal accidental bequests. This way of treating accidental bequests, while not a realistic feature of US estate taxation policy, serves to highlight the savings variability that is due to the structure of earnings. More realistic models of the passing of accidental bequests would probably increase the variability of savings rates across households.

4 Model Parameters

4.1 The Structure of Earnings

In the baseline earnings model (model 1), earnings are a deterministic function of age and all agents in the same age group receive the same earnings. We consider three variations on this baseline model. In model 2 we allow agents within an age group to have permanently different levels of earnings while maintaining the assumption that earnings for any particular agent are a deterministic function of age. In model 3 we allow an agent's earnings to depend on age and permanent idiosyncratic shocks. In model 4 we allow earnings to be a function of age as well as both temporary and permanent idiosyncratic shocks.

These earnings models are now described using the following notation. Let y_j and $\bar{y_j}$ denote the log labor endowment and the mean log labor endowment of age j agents. Earnings will then be simply the product of a common real wage and an agent's labor endowment. The four earnings specifications are then given below, where all shocks (ϵ) are independently distributed.[9]

Model 1: $y_j = \bar{y_j}$

Model 2: $y_j = y_{j-1} + (\bar{y_j} - \bar{y_{j-1}})$

Model 3: $y_j = y_{j-1} + (\bar{y_j} - \bar{y_{j-1}}) + \epsilon_{1j}$

Model 4: $y_j = y_{j-1} + (\bar{y_j} - \bar{y_{j-1}}) + \epsilon_{1j} + \epsilon_{2j} - \epsilon_{2j-1}$

The models are calibrated as follows. First, the values of the mean log earnings are selected to match the US cross-sectional age-earnings profile. The values of $\bar{y_j}$ are common across all four earnings specifications. The US profile is given in Figure 2.[10] Second, the distribution of earnings y_1 across age 1 agents as well as the distribution of the shocks (ϵ_1 and ϵ_2) must be specified for models 2-4. The variables y_1, ϵ_1 and ϵ_2 are all normally distributed, $y_1 \sim \mathrm{N}(\bar{y_1}, \sigma_{y_1}^2)$, $\epsilon_1 \sim \mathrm{N}(0, \sigma_{\epsilon_1}^2)$ and $\epsilon_2 \sim \mathrm{N}(0, \sigma_{\epsilon_2}^2)$. Finally, the variances are selected to be consistent with estimates of the earnings uncertainty present at the household level and with estimates of the inequality in the distribution of earnings. These values are listed below.

[9] In models 1-3 the labor endowment function is then $e(z,j) = exp(z + \bar{y_j})$, where in models 1-3 z is defined as 0, $(y_1 - \bar{y_1})$ and $(y_j - \bar{y_j})$ respectively. In model 4, $e(z,j) = exp(z_1 + \bar{y_j})$ and $z = (z_1, z_2) = ((y_j - \bar{y_j}), \epsilon_{2j})$.

[10] Multiply median earnings of men in cross-section data in 1978 (Social Security Bulletin) by labor force participation rates for each age group (Handbook of Labor Statistics).

Model 2: $\sigma^2_{y_1} = .54$
Model 3: $\sigma^2_{y_1} = .28$, $\sigma^2_{\epsilon_1} = .01$
Model 4: $\sigma^2_{y_1} = .28$, $\sigma^2_{\epsilon_1} = .01$, $\sigma^2_{\epsilon_2} = .01$

With these parameter values model 2 generates an earnings Gini coefficient within each age group of .40 and an overall Gini for the working age population of .42. The overall Gini matches the average US earnings Gini for men in the period 1958-77 calculated by Henle and Ryscavage (1980). In models 3 and 4 we need to set the variances of the temporary and permanent shocks to earnings. Carroll (1992) uses Panel Study of Income Dynamics data to estimate the variance in the temporary and permanent shocks to log earnings. He estimates that the permanent component of this log earnings variance is .016 and that the temporary component is .027. With these estimates the model economies would generate an earnings Gini that is above the US level. Therefore, we use these estimates as upper bounds and adjust these variances downward so as to match the US earnings Gini. The variance of the permanent shock to earnings is set at .01 in models 3 and 4. This implies that a one standard deviation shock raises or lowers earnings permanently by 10 percent. With this calibration the earnings Gini in model 3 goes from .29 among age 1 agents to .45 among agents at the retirement age.[11] The overall earnings Gini is then .41 which is slightly below the US level. In model 4 there are both permanent and temporary shocks to earnings. The variance of the permanent and temporary shocks are both set at .01. Model 4 then produces Gini coefficients both within age groups and in the overall distribution that are very similar to those in model 3.[12]

4.2 Other Parameters of the Model Economies

Table 2

[11] I set the earnings Gini for age 1 agents at .29 based on the following considerations. First, Lillard (1977) and Shorrocks (1980) estimate that the earnings Gini for young agents is .254 and .268 respectively. I treat these as lower bounds as they include only agents with nonzero earnings in the sample.

[12] We approximate models 2 and 3 with 20 points and model 4 with 60 points. In model 2 the shock z takes on 20 values between $-5\sigma_{y_1}$ and $5\sigma_{y_1}$. In models 3 and 4 the permanent shock takes on 20 values from $-6\sigma_{y_1}$ to $6\sigma_{y_1}$. The temporary shock takes on 3 values between $-1.5\sigma_{\epsilon_2}$ and $1.5\sigma_{\epsilon_2}$. All shocks are evenly spaced over these intervals. Transition probabilities are calculated by integrating the area under the normal distribution, conditional on the value of the state (see Huggett (1995)).

Model Parameters

β	σ	A	α	δ	g	N	R	s_j	n	τ	θ	$\underline{\hat{a}}$
1.011	1.5	.89594	.36	.06	.018	79	46	–	.012	–	.094	0, -w

The preference parameters (β, σ) are set using a model period of one year. The value of the discount factor β is Hurd's (1989) estimate in economies where mortality risk is accounted for separately. The value of the coefficient of relative risk-aversion σ follows the values estimated in the microeconomic studies reviewed by Prescott (1986) and Auerbach and Kotlikoff (1987).

The technology parameters (A, α, δ, g) are set as follows. The technology level A is normalized so that the wage equals 1.0 when the capital-output ratio is 3.0 and the labor input is normalized to equal 1.0. Capital's share of output α is set following the discussion in Prescott (1986). The depreciation rate δ is set to match the US depreciation-output ratio following the estimate of Stokey and Rebelo (1993). The rate of technological progress g is set to match the US growth rate of output per capita from 1950-92 as reported in the Economic Report of the President (1994).

The demographic parameters (N, R, s_j, n) are set using a model period of one year. Thus, agents are born at a real life age of 20 (model period 1) and live up to a maximum real life age of 98 (model period 79). Agents retire at a real life age of 65 (model period 46). The survival probabilities s_j are set according to the actuarial estimates in Jordan (1975). The growth rate of the population n is set to equal the average population growth rate in the US from 1950-92 as reported in the Economic Report of the President (1994, Table B32).

Tax rates (τ, θ) are set as follows. The income tax τ is set to match the average share of government consumption in output. The measure of government consumption is federal, state and local government consumption as reported in the Economic Report of the President (1994, Table B1). As the average ratio was .195 from 1959-93 the tax rate is set at $\tau = .195/(1 - \delta(K/Y))$. The tax rate is greater than .195 as capital income is taxed only after subtracting depreciation. The social security tax rate θ equals the average for the 1980s of the contribution to social security programs as a fraction of labor income. The data on contributions come from Table M-3 of the Social Security Bulletin and exclude unemployment and disability insurance contributions.

The credit limit $\underline{\hat{a}}$ is set at 0 and for comparison purposes at $-w$. A credit limit of 0 means that agents cannot borrow, whereas a credit limit of $-w$ means that agents can borrow up to one years average earnings in the economy.

5 Results

This section is organized in three subsections. First, some of the general features of the model economies are documented. Second, the main results of the paper are described. Third, we investigate the sensitivity of the main results to variations in the social security system by determining savings behavior in the absense of any social security system at all. All of the details of how the results reported here were computed are described in Huggett (1995).

5.1 General Features of the Model Economies

Before discussing the properties of the model economies, we state our measures of wealth and savings. The concept of individual wealth we use in the model economies is simply net asset holdings, $\hat{a}$. This choice reflects the fact that the concept of wealth typically measured in the US data is one that includes neither social security wealth nor the value of human capital. The notion of individual savings used is then simply the change in net asset holding across a period. Thus, savings for an age j household in state x is $a(x,j)(1+g) - \hat{a}$. This measure of savings is equal at the aggregate level to both economy-wide net savings (S) and private savings. This is because government savings are always equal to zero.

Table 3 lists a number of the aggregate properties of the model economies. All the model economies are able to approximate the average values of the US capital-output ratio and the net savings rate in the post-war period. Model economies 2-4 are all able to approximate the US income Gini.[13] However, none of the model economies matches the degree of concentration of wealth

[13]Avery et al (1984) report that the US income Gini was .39 in 1969, .42 in 1976 and .45 in 1982.

in the upper tail of the US wealth distribution.[14][15]

Table 3

Descriptive Statistics

	K/Y	S/Y	r	Income Gini	Percentage of Wealth in Top 1% 5% 20%	Zero or Negative Wealth (%)
Model 1						
$\underline{\hat{a}} = 0$	2.89	.087	6.4	.18	2.4 11.4 42.0	12
$\underline{\hat{a}} = -\hat{w}$	2.81	.084	6.8	.19	2.5 12.0 44.3	20
Model 2						
$\underline{\hat{a}} = 0$	2.97	.089	6.1	.42	9.7 32.2 68.3	13
$\underline{\hat{a}} = -\hat{w}$	2.85	.086	6.6	.43	10.7 35.3 74.4	28
Model 3						
$\underline{\hat{a}} = 0$	2.98	.090	6.1	.41	9.6 30.5 66.0	12
$\underline{\hat{a}} = -\hat{w}$	2.87	.087	6.5	.42	10.2 33.2 71.7	26
Model 4						
$\underline{\hat{a}} = 0$	2.98	.090	6.1	.41	9.6 30.7 66.0	12
$\underline{\hat{a}} = -\hat{w}$	2.88	.087	6.5	.42	10.3 33.2 71.3	26

5.2 Savings-Income Ratios in Model Economies

Table 4 presents the main findings of the paper. The table presents the savings implications of the model economies and for comparison purposes the averages of the results reported by Kuznets.[16] The findings are that a variety of earnings structures imply that in cross-section data the average savings rates are negative for low income multiples and increase as the multiple of mean income increases. Furthermore, model economies 2-4 all produce

[14] See Huggett(1995) for a discussion of the stylized facts of wealth distribution and the wealth distribution implications of model economies of this type.

[15] It is interesting that the model economies can match both the inequality in the US earnings distribution for the working age population as well as the inequality in the income distribution for the overall population while still missing the inequality in the wealth distribution.

[16] Savings rates at different income multiples are calculated by taking a 10 percent band around each income multiple and then dividing total savings of agents in the band by total income of agents in the band. Income is defined as earnings after social security taxes plus interest income and transfers.

quantitatively similar results that roughly approximate the magnitudes of the average savings rates observed in US data. This is interesting as the earnings structures differ significantly across these model economies. This suggests that features that are common to all three model economies may be key to generating this stylized fact of savings behavior. The presence of largely permanent differences in earnings abilities across agents together with the demographic structure and the structure of transfer payments are common to all of these model economies. We argue below that these are the key features of the model economies generating the observation. Thus, we find that temporary earnings shocks play at best a secondary role in producing the result.

Table 4

Savings Rates at Multiples of Mean Income

Income Multiple	US*	Model 1	Model 2		Model 3		Model 4	
		$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w	$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w	$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w
.25	-19.3	0	-7.4	-11.3	-9.4	-15.2	-11.1	-18.1
.50	-1.3	-5.1	2.9	0.4	2.1	1.1	1.8	-1.4
.75	4.8	-10.4	6.1	6.7	3.6	4.3	3.8	3.9
1.0	7.9	9.0	3.8	4.4	7.3	8.3	8.3	8.8
1.5	13.0	23.8	11.1	13.7	17.0	17.1	16.4	16.6
2.0	16.5	-	20.0	20.8	20.0	20.2	20.7	20.8
3.0	22.4	-	25.6	25.5	26.9	26.5	26.1	26.0
4.0	27.1	-	28.9	29.7	28.8	28.5	28.7	28.7
7.0	37.3	-	32.1	32.8	31.9	32.4	33.3	33.4
10.0	39.2	-	26.6	28.0	26.5	26.4	28.9	28.6

* Averages from Kuznets (1953) and Projector (1968)

In the remainder of this section we attempt to understand the results in Table 4 at a deeper level. We focus the analysis on models 2-4 as only these models produce enough income heterogeneity to match up to the savings data. Nevertheless, we start out by discussing the individual savings behavior in model 1. This is because it helps in understanding the more complex behavior in model 2. Figure 3 graphs the savings rates for an individual agent over time in model 1. The savings patterns are determined by whether after-tax income lies above or below consumption at a point in time. At the beginning of life the borrowing constraint binds and there are no savings.

Afterwards, after-tax income increases faster than does consumption and therefore agents save. Agents save until just before the retirement age. At this time earnings fall quite sharply while consumption continues to grow. Thus, agents dissave a large fraction of income at this time. At age 65 all agents receive retirement benefits. With the receipt of these benefits the rate of dissavings is much more moderate. At extreme old age agents exhaust all assets and hence savings rates are zero.

[Insert Figure 3 Here]

The savings patterns at the individual level in model 2 largely reflect the patterns described for model 1. However, there are some important differences as agents within a cohort have different levels of earnings. Figure 3 graphs the savings rates over time for agents with different earnings abilities from the time of birth. Recall that there are 20 levels of earnings abilities within an age group when the earnings process in model 2 is approximated. An earnings level of 20 is the highest and 1 is the lowest level. Thus, the figure shows that agents with high earnings ability (shock 15) save at higher rates before retirement than agents with medium (shock 10) or low (shock 5) earnings ability. Given that all agents have identical and homothetic preferences, one might have guessed that savings of any agent would have always been proportional to the savings of any other agent in the same age cohort. This is not true as social security benefits are not proportional to contributions. In addition, agents receive a common transfer due to the taxation of accidental bequests. Figure 4 shows that these transfers lead to substantially different savings rates for agents in the same age group, even without any differences in preferences.

[Insert Figure 4 Here]

We are now ready to describe how the behavior in model 2 aggregates to generate the results in Table 4. First, the agents at low multiples of mean income are largely the very youngest agents and also the agents just before the retirement age. This fact can be read off of the cross-sectional age-income distribution described in Figure 5. The agents at low income multiples tend to have zero savings rates or are dissaving as Figure 4 shows. When the credit limit is set to allow borrowing these savings rates are even smaller as the young can dissave. As the multiple of mean income increases the composition of the agents changes. There are more agents above age 25 when savings rates start to increase and there are fewer agents just before the retirement age. Both of these considerations dictate that average savings rates should increase. At higher income multiples the composition changes to include higher fractions of middle-age agents and agents in the upper tail of the earnings distribution for their age group. These agents have very high savings rates as Figure 4 illustrates.

[Insert Figure 5 Here]

We now investigate the individual and aggregate savings behavior in the models with temporary and permanent shocks. We focus the analysis on model 4. One way to understand why the results for model 4 are so similar to those for model 2 is to produce the analog of Figures 4 and 5 for model 4. This is done in Figures 6 and 7. Figure 6 shows that there are large differences in savings rates within age groups at different percentiles of the income distribution. The patterns in Figure 6 are similar to those in Figure 4. We argue below that Figures 4 and 6 are similar mainly because of permanent differences in earnings and the structure of the transfer system and only partially because of the presence of temporary shocks. Figure 7 shows that the age-income distributions in the two models are almost identical. Thus, the models produce very similar results for the structure of savings rates at given multiples of mean income.

[Insert Figures 6 and 7 Here]

One surprising feature of Table 4 is that the results of models 3 and 4 are so similar. A natural conjecture is that temporary shocks could be a quantitatively important source of differences in savings rates at different income multiples. The conjecture is based on the assumption that positive temporary shocks will be largely saved, whereas negative temporary shocks will be largely dissaved. High income groups should have a high fraction of agents receiving positive temporary shocks and low income groups should have a high fraction receiving negative temporary shocks. It turns out that theory does predict this type of savings behavior. In particular, it is true that off corners part of a positive temporary shock is saved and part of a negative temporary shock is dissaved. Savings is partial in that it is strictly between 0 and 100 percent of the after tax change in earnings produced by the temporary shock. [17]

[17] Here is a sketch of the argument. Graph each side of the following Euler equation as a function of a':

$$u'(resources - a') = \beta s_{j+1} E[V_1(a', z', j+1)|z]$$

The left hand side (LHS) is increasing in a', while the right hand side (RHS) is decreasing

We now measure the magnitudes of the marginal savings rates out of temporary shocks. These marginal savings rates are defined as the ratio of additional savings to the change in after-tax income produced by the shock. We find that in model 4 the median marginal savings rate for the working-age population is to save 94 percent of a temporary shock. This occurs at both of the credit limits considered.[18] When the credit limit is set to allow borrowing ($\hat{\underline{a}} = -w$), the distribution of marginal saving rates in the economy is quite concentrated around the median. The central 80 percent of the distribution of marginal savings rates in the economy lies between 89 and 97 percent. When the credit limit is set at zero, marginal savings rates are not as concentrated around the median. A high percentage (12 percent) of agents are exactly at the corner of the borrowing constraint. These agents have low marginal savings rates. The remaining agents in the economy have marginal savings rates that are quite concentrated around the median value.

To understand why the results in Table 4 for models 3 and 4 are so similar consider Figure 8. This figure graphs savings rates in model 3 within age groups at different percentiles of the age-specific income distribution. Figure 8 is quantitatively very similar to Figure 6. Thus, the large differences in savings rates within age groups occur even without temporary shocks. This result is driven by permanent earnings differences and the structure of transfers as in model 2. It is therefore clear why temporary shocks are not quantitatively very important even though the marginal savings rates out of these shocks are large. The answer is simply that there are already large differences in average savings rates at different percentiles of the age income distribution. Thus, the high marginal savings rates do not dramatically alter these average savings rates unless the magnitude of the temporary shocks is much larger. These shocks have a standard deviation of 10 percent of income.

[Insert Figure 8 Here]

To close this section we ask the following question. To what degree do the results in Table 4 depend on differences in savings rates within age groups versus simply differences in average savings rates across age groups? To answer this question we set savings rates of all agents within an age group equal to the average for the age group. This involves changing the decision

in a' by concavity of V. A positive temporary shock shifts the LHS towards the right without affecting the RHS. This demonstrates the claim.

[18] It also occurs both when comparing the savings change in moving from the middle to the high temporary shock and in moving from the middle to the low temporary shock.

rule $a(x, j)$ in a simple way. The results of this experiment are shown in Table A1 in the Appendix. The findings are that there is still some tendency for savings rates to increase with income even without differences in savings rates within age groups. However, at a quantitative level the differences in savings rates within an age group are quite important in producing the results in Table 4.

5.3 What is the Role of Social Security?

The results from the previous section indicate that permanent earnings differences together with the structure of transfer payments are features which are capable of producing qualitatively and to some degree quantitatively the cross-section pattern of US household savings rates. In this section we analyze the sensitivity of this result to changes in the social security system. The motivation for the sensitivity analysis comes from three main sources. First, there have been large changes over time in US government transfer institutions. In particular, before 1935 the US social security system did not exist. Since then the magnitude of government supported inter-generational transfers have increased substantially.[19] Second, the results in Table 4 could be quite sensitive to changes in the importance of transfer payments. This is because savings rate differences within age groups were quantitatively important in producing these results. These differences in savings rates were due in part to social security transfers. Third, the data from Kuznets (1953, Table 48) for 1929 show that high income households saved on average a substantially higher fraction of income than low income households even before the US social security system was established.[20] Thus, if the results in Table 4 were particularly sensitive to changes in transfers, then the explanation of the US cross-section savings facts offered here would be much less convincing.

In this section we consider a transfer system in which all social security

[19] It is quite possible that social security acted at least in part to replace transfers that were already occurring within extended families or across families. Thus, it would be interesting to know something about the structure of transfers in the US before social security was formally introduced.

[20] Kuznets provides two separate estimates in 1929 for savings rates at different income multiples. We list in Table 1 Kuznets' preferred estimate. The other estimate produces lower savings rates at high income multiples. Nevertheless, both estimates show large differences in saving rates at different income multiples.

transfers are eliminated while still maintaining the transfers that come from the taxation of accidental bequests. Thus, the social security tax is set at zero. This is an extreme way of examining model sensitivity. Transfer systems that are intermediate between the no social security system examined here and the system analyzed in Table 4 are likely to have properties lieing between these extremes.

Table 5

Savings Rates at Multiples of Mean Income: No Social Security

Income Multiple	US*	Model 2		Model 3		Model 4	
		$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w	$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w	$\underline{\hat{a}}$=0	$\underline{\hat{a}}$=-w
.25	-19.3	-48.2	-48.9	-54.5	-59.1	-50.8	-58.0
.50	-1.3	2.0	-3.7	1.4	0.7	0.4	-0.8
.75	4.8	11.1	10.2	17.7	16.2	17.0	16.3
1.0	7.9	24.1	22.6	24.9	24.3	24.5	24.0
1.5	13.0	27.3	27.9	27.4	27.9	29.4	29.6
2.0	16.5	32.7	33.3	30.7	31.0	32.6	32.7
3.0	22.4	34.4	35.2	34.9	35.0	35.2	35.3
4.0	27.1	35.7	36.2	34.6	34.8	36.7	36.9
7.0	37.3	26.2	26.8	37.1	37.4	38.2	38.3
10.0	39.2	20.3	20.5	24.4	24.7	30.3	30.1

* Averages from Kuznets (1953) and Projector (1968)

The main findings of the sensitivity analysis are presented in Table 5. Table 5 shows that, without social security, savings rates still increase with the multiple of mean income. In fact, the differences in savings rates at different income multiples are even greater than the results in Table 4. Why is this so? To answer this question consider Figures 9 and 10. These figures characterize, respectively, the age-income distribution and the age-savings rate distribution in model 2 without social security transfers. Figure 9 shows that the agents at the lowest income multiples are largely well into retirement. It is clear from Figure 10 that these agents are dissaving at high rates. Thus, it is clear why these models produce lower savings rates at low income multiples than in the same models with social security transfers. It is simply that with social security the lowest income households were the youngest agents, whereas in the absence of social security these agents are mainly the oldest agents. At higher income multiples the composition changes to include groups that are either in the middle of their life cycle or are in the upper part of the income distribution for their age group. These agents have very high savings rates as Figure 10 demonstrates.

To what degree do the results in Table 5 depend on differences in savings rates within age groups versus differences in average savings rates across age groups? It is apparent from Figure 10 that there are differences in savings rates within age groups, although the differences before retirement between middle (shock 10) and high (shock 15) earnings abilities appear to be smaller than with social security transfers. The answer to this question is given in Table A2 in the appendix. In this table we set all savings rates in an age group equal to the average of the group. The findings are that savings rate differences across age groups are the dominant cause of why savings rates increase with income in cross section when there are no social security transfers. This is true of all the models.

[Insert Figures 9 and 10 Here]

6 Conclusion

The paper attempts to understand why high income households save on average more than low income households in US cross-section data. The main findings are that the calibrated life-cycle economies that we consider predict this type of behavior. The key features of the model economies that produce this savings behavior are the age structure, the structure of social security transfers and the presence of largely permanent differences in earnings across households. We also find that neither preference heterogeneity nor a specific pattern of earnings shocks were essential in producing this result. The fact that temporary earnings shocks have only a modest contribution to decreasing the savings rate at low incomes and increasing the savings rate at high incomes was a surprising finding of the investigation. Without a social security system, the model economies also predict that high income households save more than low income households. However, the role played by the fact that households differ in age is much more important in the absence of social security transfers.

The finding that features of the transfer system are quantitatively important in explaining savings observations mirrors the results emphasized by other researchers. In particular, Gokhale, Kotlikoff and Sabelhaus (1995) argue that the decline in US savings rates since the 1980's can be traced in part to the increased importance of government supported intergenerational transfers from the young towards the old. Hubbard et al (1995) argue that low levels of wealth holding for some segments of the population can arise when the receipt of a transfer is conditioned on the level of wealth holdings.

The model economies investigated here have a number of empirical implications that could be used to judge the plausibility of the explanation of the relation between savings and income in cross-section data advanced in this paper. One of these implications is that US savings rates and age in cross section in recent decades should resemble the pattern in Figures 4, 6 and 8. The key feature of these figures is that savings rates typically increase within an age group as income increases.[21] This should hold for age groups that are short of the retirement age. For age groups that are past the age of retirement we already know that the strong dissavings properties of these figures (almost everyone dissaves) are not a feature of US data.[22] (Mention the data in Atanasio (1994) here.) Time will tell if more satisfactory models of savings behavior will have similar implications for the importance of age, earnings and the structure of transfers for explaining cross-section savings behavior.

[21] Computations of the importance of savings rate differences within age groups versus across age groups for the cross-section facts could also be done with US data. It would be interesting to see if the within-age-group effect for the cross-section facts has become more important as social security transfer payments have become more important.

[22] See Kotlikoff (1989 Ch. 2) and Hurd (1990) for a review of and a guide to the empirical literature on this topic.

REFERENCES

R. AIYAGARI (1994), "Uninsured Idiosyncratic Risk and Aggregate Savings," *Quarterly Journal of Economics* **109**, 659-684.

O. ATANASIO (1994), " Personal Saving in the United States," in International Comparisons of Household Saving; edited by J. Poterba; University of Chicago Press.

A. AUERBACH AND L. KOTLIKOFF (1987), " Dynamic Fiscal Policy," Cambridge University Press.

R. AVERY G. ELLIEHAUSEN G. CANNER T. GUSTAFSON (1984), "Federal Reserve Bulletin," 70; 679-92.

R. AVERY AND A. KENNICKELL (1991), "Household Saving in the US," Review of Income and Wealth; 409–32.

B. BOSWORTH G. BURTLESS AND J. SABELHAUS (1991), " The Decline in Saving: Evidence from Household Surveys," *Brookings Papers on Economic Activity* **1**, 183-241.

D. BRADY AND R. FRIEDMAN (1950), "Savings and the Income Distribution," in Studies in Income and Wealth; National Bureau of Economic Research.

C. CARROLL (1992), "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence," *Brookings Papers on Economic Activity* **2**, 61–135.

J. FISHER (1952), "Income, Spending and Saving Patterns of Consumer Units in Different Age Groups," Studies in Income and Wealth; Volume 15.

I. FRIEND AND S. SCHOR (1959), "Who Saves?," Review of Economics and Statistics; xx-yy.

J. GOKHALE L. KOTLIKOFF AND J. SABELHAUS (1995), "Understanding the Postwar Decline in United States Saving: A Cohort Analysis," mimeo.

P. HENLE AND P. RYSCAVAGE (1980), "The Distribution of Earned Income Among Men and Women," Monthly Labor Review; 3-10.

R. HUBBARD J. SKINNER AND S. ZELDES (1995), " Precautionary Savings and Social Insurance," Journal of Political Economy; 360-399.

M. HUGGETT (1995), "Wealth Distribution in Life-Cycle Economies," University of Illinois; mimeo.

M. HURD (1989), "Mortality Risk and Bequests," *Econometrica* **57**, 7779-813.

M. HURD (1990), "Research on the Elderly:Economic Status, Retirement, and Consumption and Saving," *Journal of Economic Literature* **28**, 565-637.

A. IMROHOROGLU, S. IMROHOROGLU AND D. JOINES (1995), "A Life Cycle Analysis of Social Security," *Economic Theory* **6**, 83-114.

C. JORDAN (1975), "Life Contingencies," The Society of Actuaries;Second Edition.

L. KOTLIKOFF (1989), "What Determines Savings?," The MIT Press.

S. Kuznets (1953), "Shares of Upper Income Groups in Income and Savings," New York; National Bureau of Economic Research.

J. Laitner (1992), "Random Earnings Differences, Lifetime Liquidity Constraints and Altruistic Inter generational Transfers," *Journal of Economic Theory* **58**, 135-170.

L. Lillard (1977), "Inequality: Earnings vs. Human Wealth," *American Economic Review* **67**, 42-53.

D. Parsons and D. Munro (1978), " Intergenerational Transfers in Social Security," ed. M. Boskin; The Crisis in Social Security: Problems and Prospects.

E. Prescott (1986), "Theory Ahead of Business Cycle Measurement," Federal Reserve Bank of Minneapolis Quarterly Review, 9-22.

D. Projector (1968), "Survey of Changes in Family Finances," Board of Governors of the Federal Reserve System.

J.V. Rios-Rull (1995), "Models With Heterogeneous Agents," in T. Cooley, ed.; Frontiers of Business Cycle Research, Princeton University Press.

A. Shorrocks (1980), "Income Stability in the United States," in The Statics and Dynamics of Income, ed. N. Klevmarken and J. Lybeck; Tieto Ltd.

T. Smith and J. Frechtling (1951), "1951 Survey of Consumer Finances," Distribution of Consumer Saving in 1950, Federal Reserve Bulletin, 1061-78.

N. Stokey and S. Rebelo (1993), "Growth Effects of Flat-Rate Taxes," University of Rochester, mimeo.

7 Appendix

Table A1

Savings Rates at Multiples of Mean Income
[Equal Savings Rates within Age Groups]

Income Multiple	US*	Model 2		Model 3		Model 4	
		$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$	$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$	$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$
.25	-19.3	8.2	10.3	7.4	8.0	6.8	5.4
.50	-1.3	5.5	2.3	6.0	0.0	5.8	0.1
.75	4.8	10.8	12.3	7.7	9.6	8.3	9.6
1.0	7.9	7.1	6.8 x	12.0	12.3	13.1	13.1
1.5	13.0	10.7	13.6	17.0	16.7	16.8	16.5
2.0	16.5	17.4	18.0	16.7	16.7	17.5	17.3
3.0	22.4	19.2	18.5	19.0	18.5	18.3	18.1
4.0	27.1	19.9	20.5	17.6	17.4	17.8	17.8
7.0	37.3	27.4	23.5	17.5	18.6	18.7	19.0
10.0	39.2	29.1	31.0	17.7	18.7	19.8	20.3

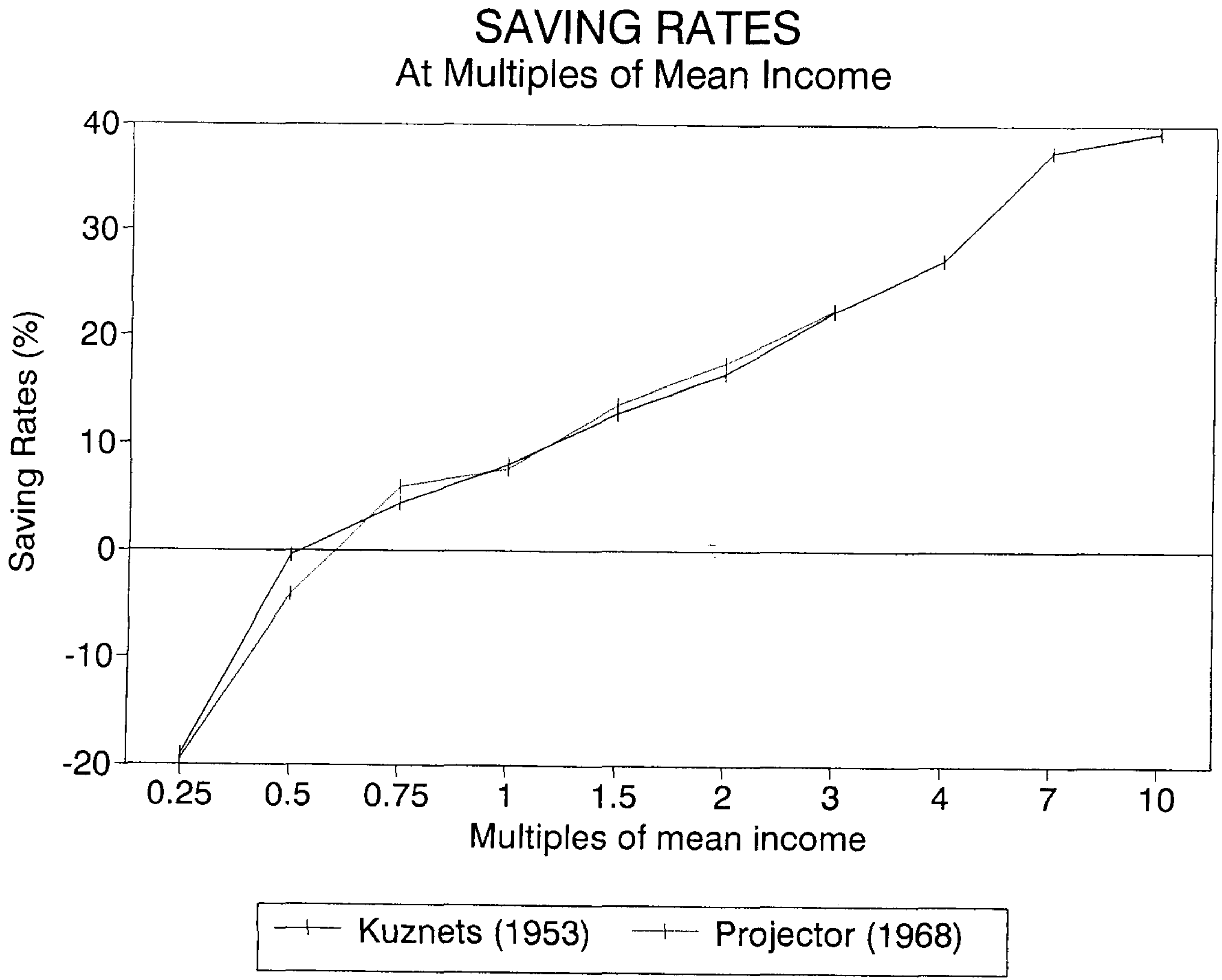
* Averages from Kuznets (1953) and Projector (1968)

Table A2

Savings Rates at Multiples of Mean Income: No Social Security [Equal Savings Rates within Age Groups]

Income Multiple	US*	Model 2		Model 3		Model 4	
		$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$	$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$	$\underline{\hat{a}}=0$	$\underline{\hat{a}}=-w$
.25	-19.3	-52.9	-60.0	-49.2	-51.6	-50.8	-50.4
.50	-1.3	7.4	6.1	7.3	6.2	0.4	5.2
.75	4.8	20.7	21.3	21.2	20.0	17.1	19.6
1.0	7.9	27.2	27.5	26.7	26.1	24.5	25.5
1.5	13.0	30.7	30.0	26.8	27.2	29.5	28.7
2.0	16.5	32.2	32.6	29.1	29.2	32.6	30.3
3.0	22.4	33.1	32.3	30.7	30.7	35.1	31.5
4.0	27.1	34.5	34.7	29.2	29.5	36.7	31.7
7.0	37.3	36.0	36.1	32.7	33.1	38.1	32.9
10.0	39.2	37.3	37.3	30.0	30.1	30.3	33.0

* Averages from Kuznets (1953) and Projector (1968)



SAVING RATES
At Multiples of Mean Income
Saving Rates (%)
40
30
20
10
0
-10
-20
0.25
0.5
0.75
1
1.5
2
3
4
7
10
Multiples of mean income
Kuznets (1953)
Projector (1968)

FIGURE 1

EARNINGS PROFILE

(Ratio to Overall Mean)

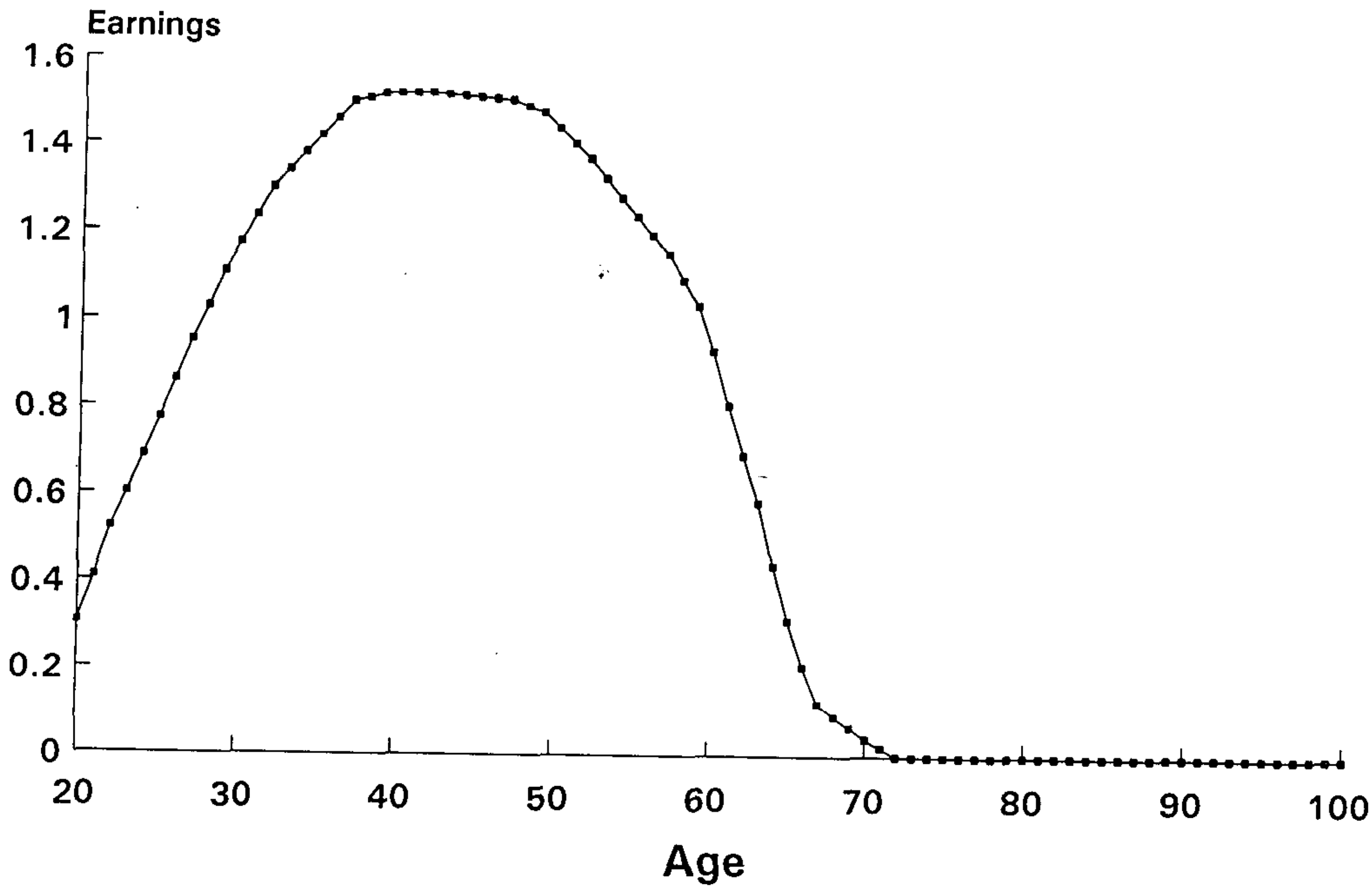
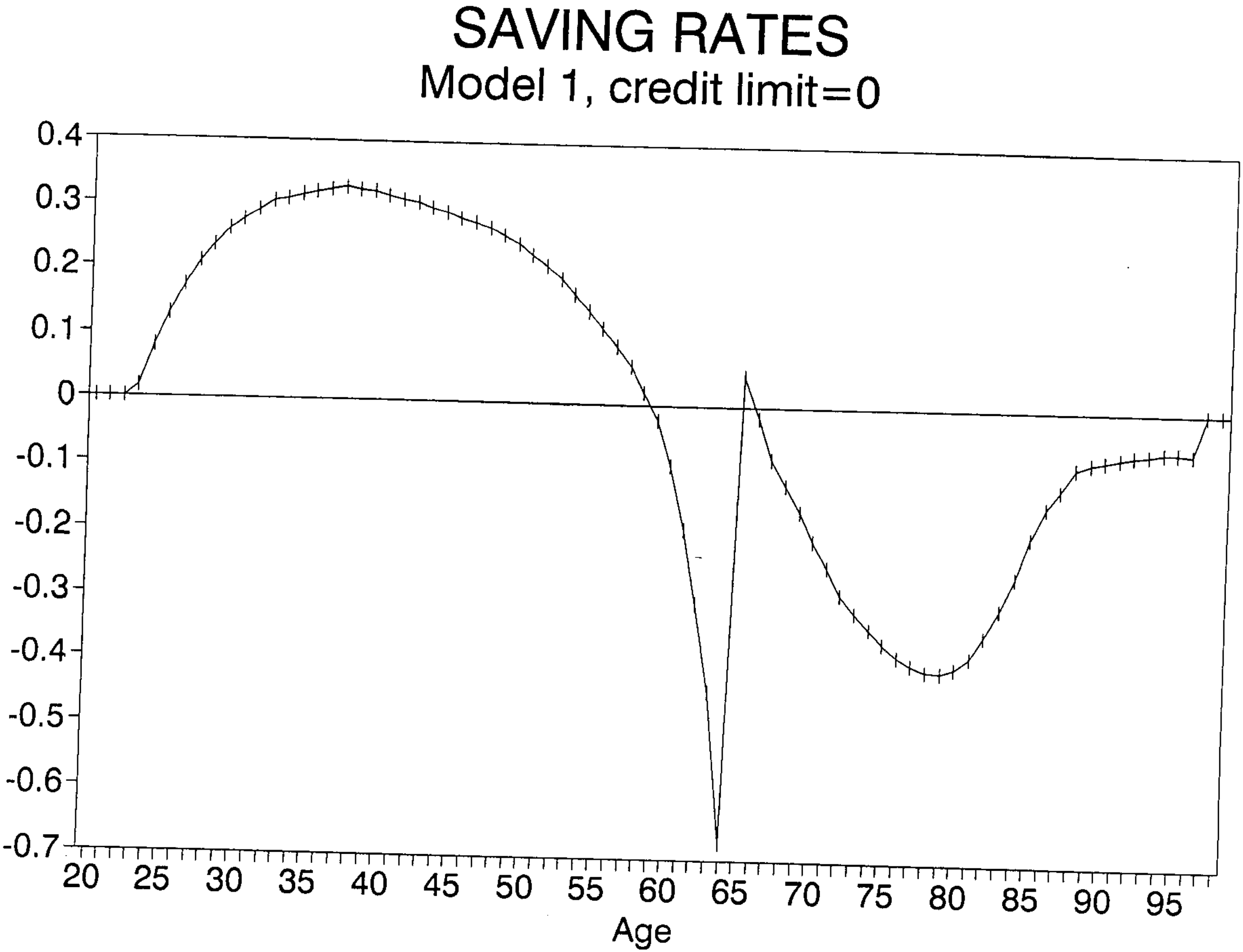


FIGURE 2



SAVING RATES
Model 1, credit limit=0
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age

FIGURE 3

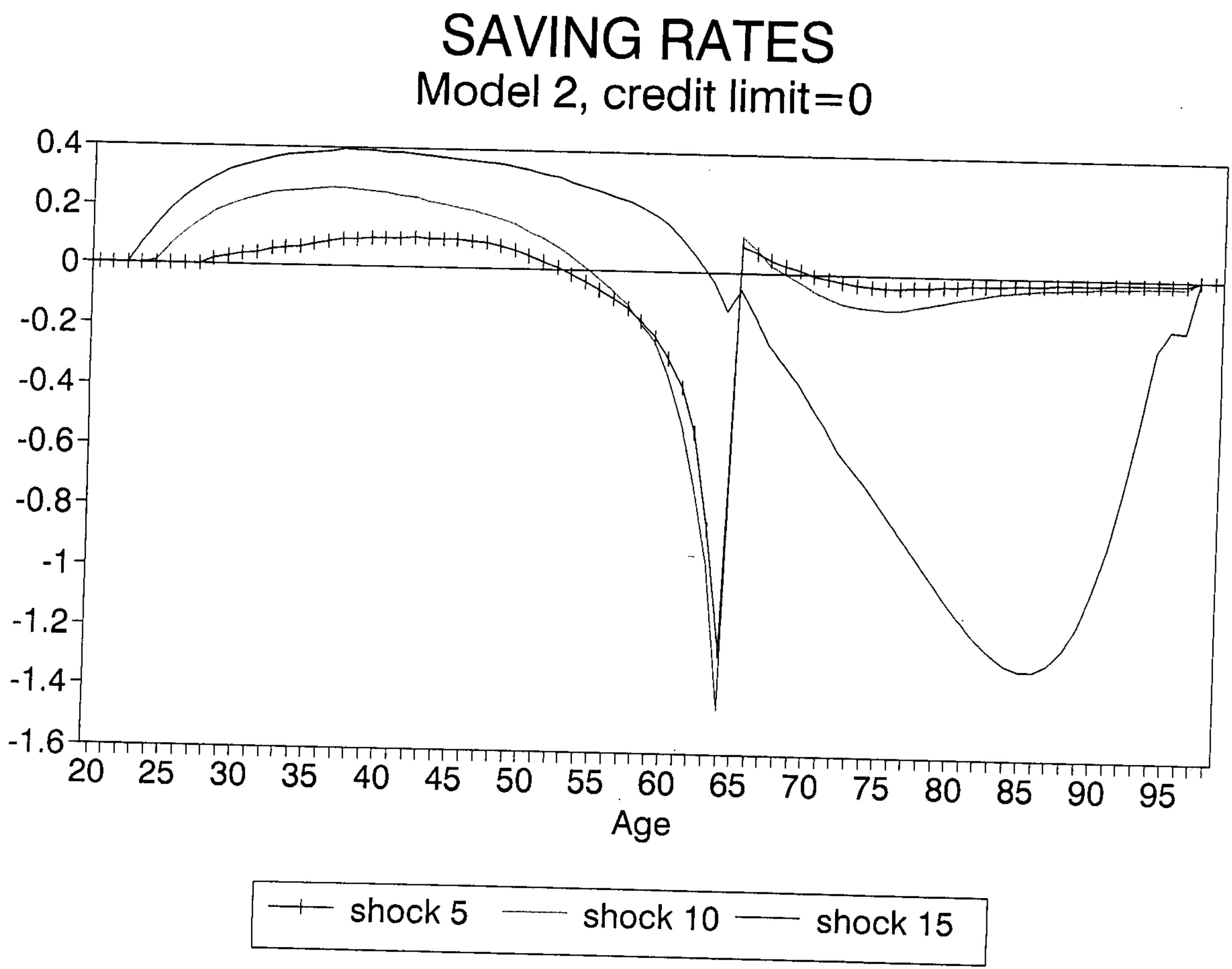
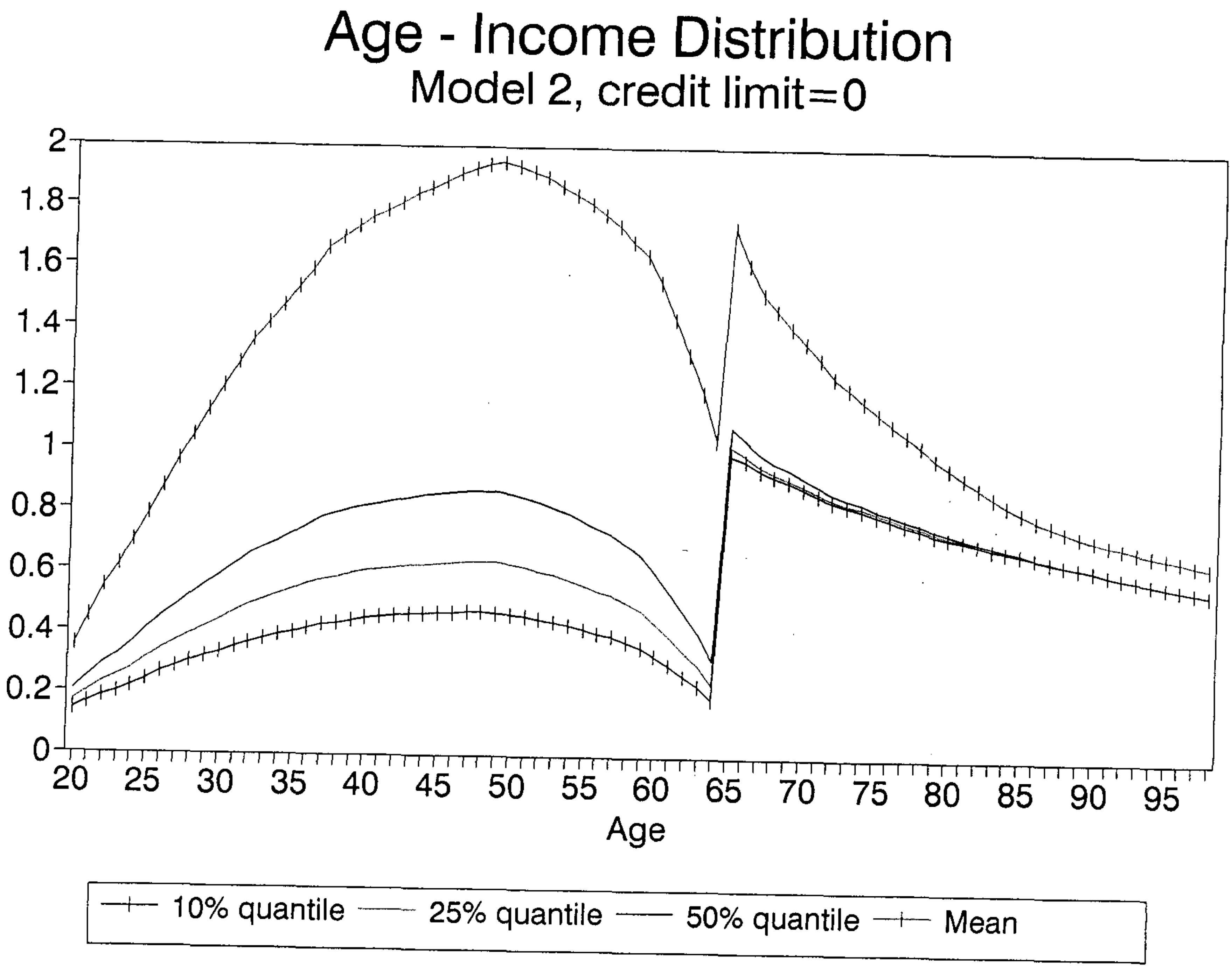

SAVING RATES
Model 2, credit limit=0
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
shock 5
shock 10
shock 15

FIGURE 4



Age - Income Distribution
Model 2, credit limit=0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
10% quantile
25% quantile
50% quantile
Mean

FIGURE 5

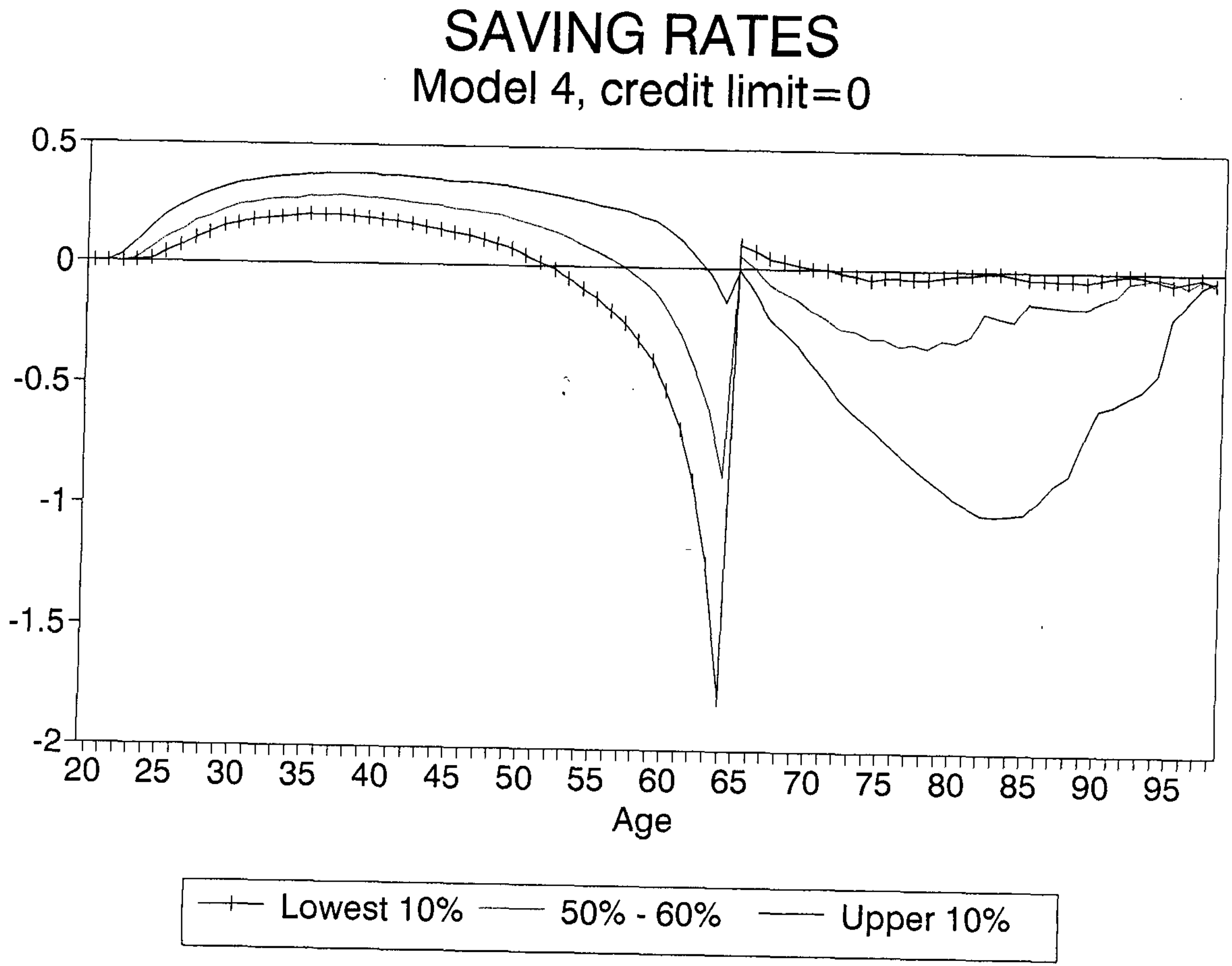
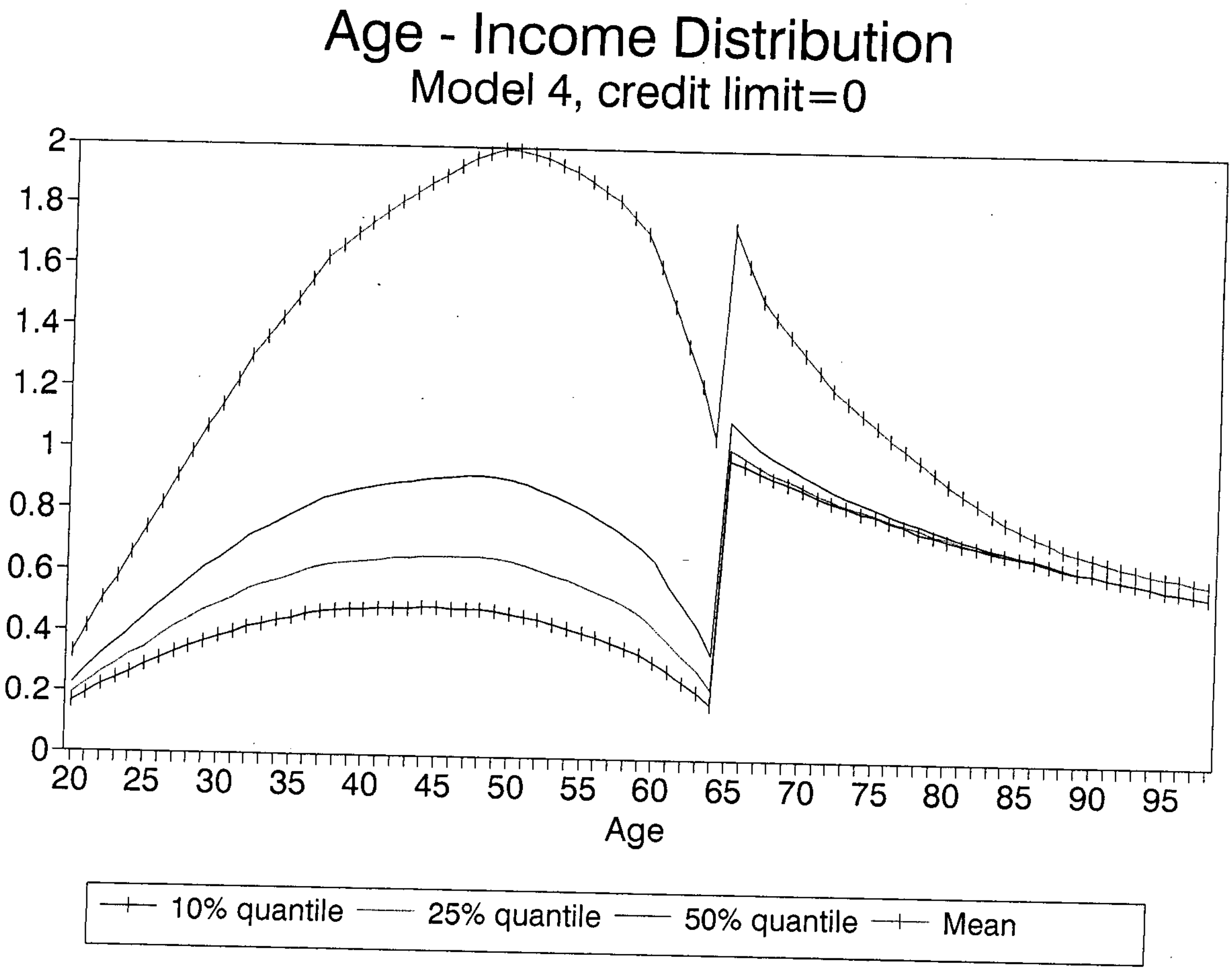

SAVING RATES
Model 4, credit limit=0
0.5
0
-0.5
-1
-1.5
-2
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
Lowest 10%
50% - 60%
Upper 10%

FIGURE 6



Age - Income Distribution
Model 4, credit limit=0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
10% quantile
25% quantile
50% quantile
Mean

FIGURE 7

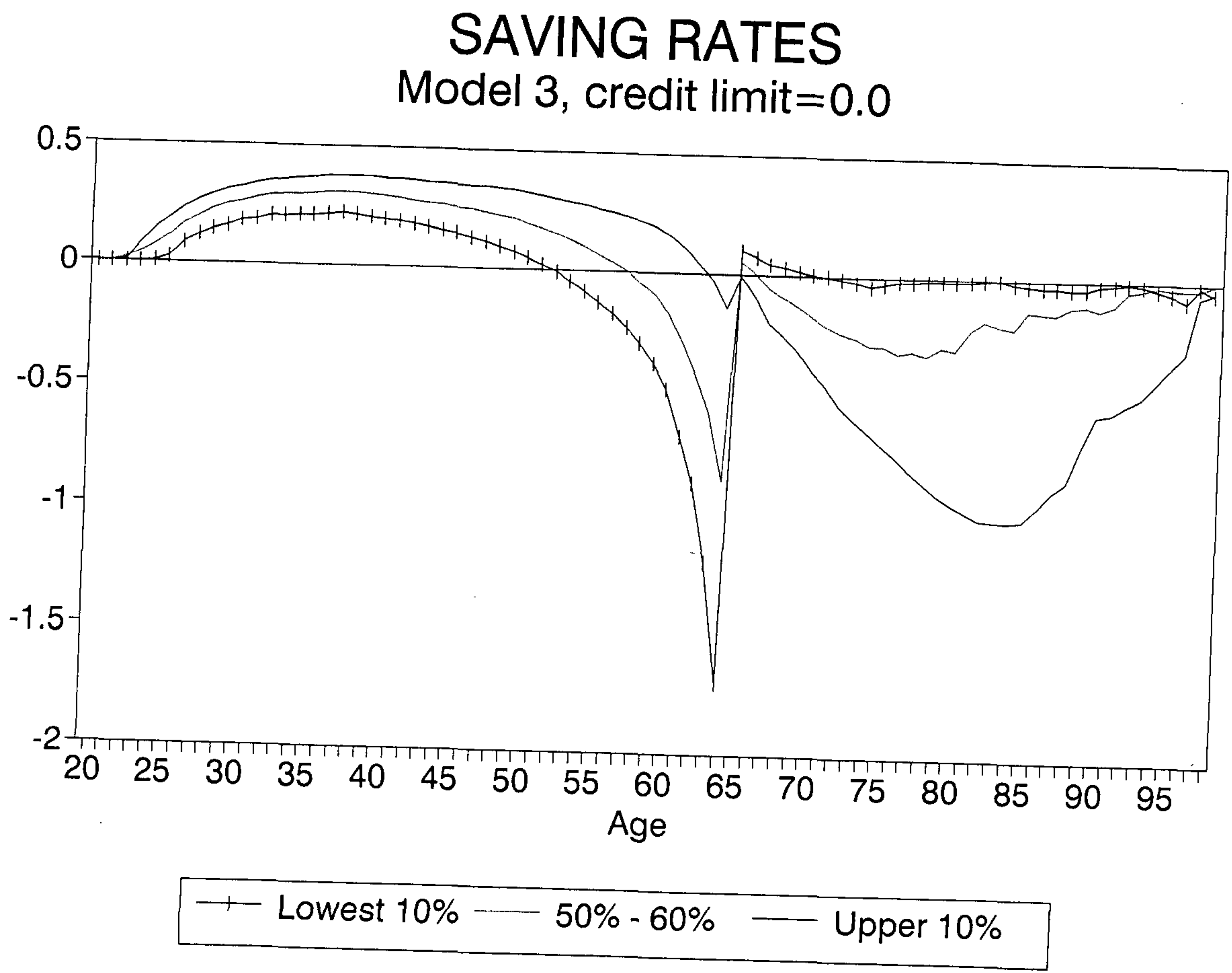
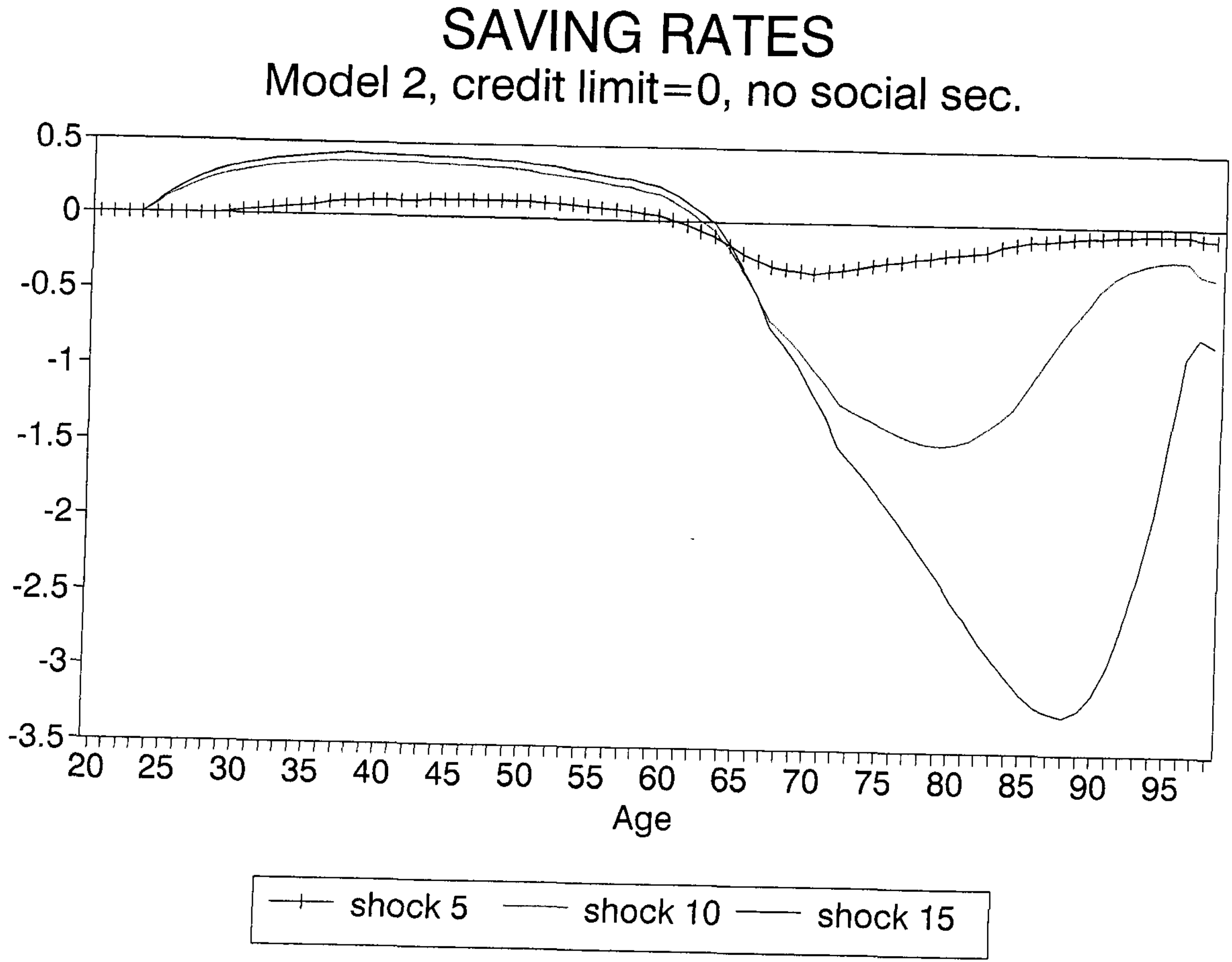

SAVING RATES
Model 3, credit limit=0.0
0.5
0
-0.5
-1
-1.5
-2
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
Lowest 10%
50% - 60%
Upper 10%

FIGURE 8



SAVING RATES
Model 2, credit limit=0, no social sec.
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Age
shock 5
shock 10
shock 15

FIGURE 9

Age - Income Distribution
Model 2, credit limit=0, no social sec.

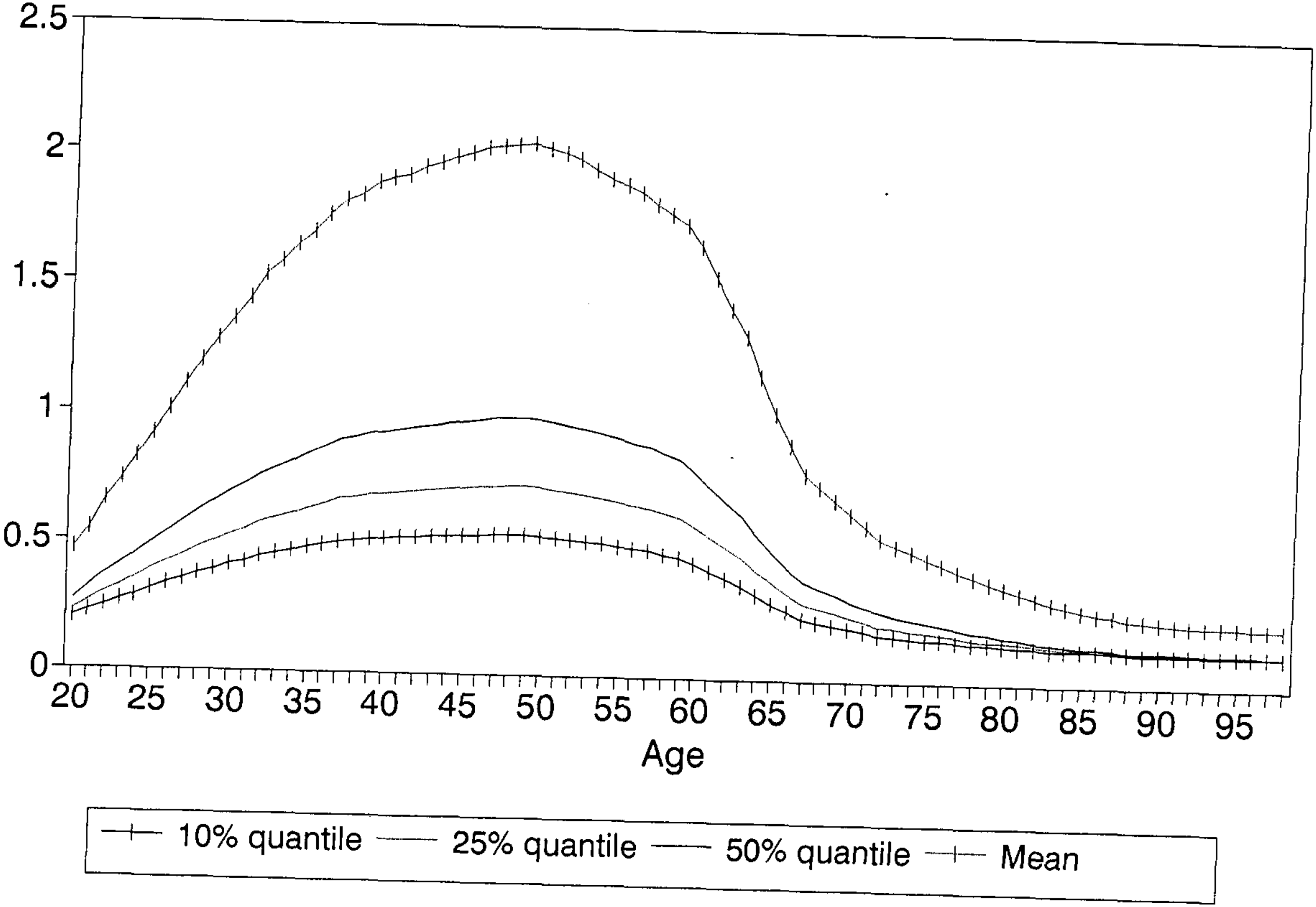


FIGURE 10