ABSTRACT

Life-Cycle Consumption and Wealth Paths at Older Ages

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According to the simplest version of the life-cycle model, consumption should decline in old age: increasing mortality risk increases the effective discount rate which will increase the attractiveness of consumption today relative to consumption in the future. Yet, we have not had good panel data on consumption with which to test this fundamental prediction. Rather we have had to rely on partial measures of consumption or on wealth change. Partial consumption is only valid if the composition of consumption does not change with age or with the level of consumption. Panel wealth is subject to considerable measurement error and to unanticipated capital gains and losses, both of which can obscure any life-cycle effects. This paper is based on two waves of the Consumption and Activities Mail Survey, which has complete measures of spending by a random sample of 5000 Health and Retirement Study households in 2001 and 2003 and up to seven waves of the HRS. We estimate life-cycle consumption paths of single people in their late 60s and beyond, and compare the slopes with predictions from theoretical models of life-cycle consumption. We compare evidence about life-cycle models based on consumption with evidence based on wealth change calculated over the same households over the same time period. For couples we report consumption and wealth change and compare these changes with predictions from a previously estimated model.

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May, 2006

Financial support from the National Institute on Aging is gratefully acknowledged

Introduction

According to the life-cycle model of consumption, individuals save during their working lives and use their savings to finance consumption following retirement (Modigliani & Brumberg, 1954). An important variable for the empirical analysis of the life-cycle model is the rate of saving, the difference between income and consumption. The rate of saving can be used directly to help understand the future economic status of an individual or a cohort, and it can be used to estimate utility function parameters in a life-cycle context. However, because household surveys have not had a complete measure of consumption, it has generally been necessary to measure saving as the first-difference in wealth. An important difficulty with this approach is that wealth is measured with considerable observation error: even if the observation error is white noise, the first-difference of a variable that may have little systematic change over a short time period can consist largely of white noise (Browning & Lusardi, 1996). Furthermore, wealth change incorporates capital gains, which can dominate wealth change in panel data. Thus, for example, if assets increase over several years due to an unexpected increase in their valuation, it will appear that elderly individuals engage in active saving unless the capital gains are eliminated.

An alternate and more direct way to estimate the behavioral parameters in a life cycle model of consumption is to base estimation on panel observations of consumption. The rate of change of consumption (the Euler equation) can be derived directly from the first-order conditions for utility maximization in a life-cycle model (Browning & Lusardi, 1996). The slope of the consumption path and how the slope varies with covariates such as mortality risk reveal directly important utility function parameters such as the time rate of discount and the risk aversion parameter (Hurd, 1989). Because of the advantages of estimating the Euler equation, the demand by researchers for panel data on consumption has been very strong in the life-cycle empirical literature and in the macro consumption literature.

A large number of empirical papers have been based on the panel measures of food consumption in the PSID, even though such data are not likely to be an adequate measure of consumption for the purpose of estimating life-cycle models.[1] For example, food consumption is unlikely to be separable in the utility function from consumption of other nondurables: increases in food spending will be accompanied by increases in other nondurable spending of an unknown magnitude.[2] In the CEX, the fraction of total consumption accounted for by food varies with income.[3] The fraction also varies with age, which makes it inappropriate for the estimation of life-cycle models: A key parameter in a life-cycle model is risk aversion, which can be econometrically identified by variation in consumption as mortality risk varies. In that the main determinant of mortality risk is age, systematic changes with age in the fraction of expenditures for food will obscure the variation in total consumption due to mortality risk. Thus, if actual spending declines with age as specified by the LCM, spending on food will decline by a

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[1] Hall & Mishkin, 1982; Zeldes, 1989; Altug & Miller, 1990; Shea, 1995; Ziliak *et al.*, 2003 are just some of many examples. Indeed, about half of the life-cycle consumption models discussed by Browning and Lusardi were fit to panel data based on PSID food consumption (Browning and Lusardi, 1996, Table 5.1).

[2] Attanasio and Weber (1995).

[3] See http://www.bls.gov/cex/2002/share/income.pdf for tables created by BLS from the CEX.

smaller amount causing underestimation of the actual decline. An additional difficulty in basing estimation at the household level on PSID food is the very substantial observation error: Runkle (1991) estimated that 76% of the year-to-year variation in PSID food consumption is due to noise.

In this paper we use new panel data on total spending to estimate directly the Euler equation over household-level observations. The data are from the Consumption and Activities Mail Survey, which has complete measures of spending by a random sample of 5000 Health and Retirement Study (HRS)households in 2001 and 2003. We estimate life-cycle consumption paths of single people in their late 60s and beyond based on consumption change between the CAMS waves and compare the slopes with predictions from theoretical models of life-cycle consumption. We compare evidence about life-cycle models based on consumption with evidence based on wealth change calculated over the same households over the same time period. For couples we report consumption and wealth change and compare these changes with predictions from a previously estimated model.

Theoretical structure

Our model of consumption is based on a life-cycle model that has these features and assumptions: life-time utility is based on time-separable utility from consumption and from bequests (Yaari, 1965); the only uncertainty is the date of death; resources are initial bequeathable wealth and a stream of annuities; bequeathable wealth cannot become negative, and, therefore, borrowing against future annuities is not allowed.

Singles Model.

As specified by Yaari, there is only one economic agent so the model is only appropriate for single people. Therefore, we will refer to it as the singles model. We discuss the couples model below.

The solution to the singles model is:

(1) $$\frac{du_t}{dt} = u_t(h_t + \rho - r) - h_t V_t$$

for $w_t > 0$. $c_t =$ income from annuities when $w_t = 0$, and w_0 is given.[4] Here

$u_t =$ marginal utility of consumption at time t

$h_t =$ mortality risk (mortality hazard);

$\rho =$ the subjective time rate of discount;

$r =$ interest rate which is known and fixed;

$w_t =$ bequeathable wealth at t ;

$V_t =$ marginal utility of bequests at time t , which will depend on the personal characteristics of potential inheritors such as the economic status of any children in an altruistic model or in a strategic bequest model;

The first order condition can be written in terms of consumption

[4] See Hurd, 1989, for a derivation.

(2) $$\frac{d\ln c_t}{dt} = -\frac{1}{\gamma_t}(h_t + \rho - r) + \frac{h_t}{\gamma_t}\left(\frac{V_t}{u_t}\right)$$

where $\gamma_t = -c_t u_{tt}/u_t$ is a measure of risk aversion evaluated at c_t and $u_{tt} = du_t/dc_t$. This is an Euler equation modified to include mortality risk and a bequest motive but excluding rate-of-return risk.

We will estimate this directly under the assumption that there is no bequest motive.[5], and following a substantial amount of literature that the utility function is constant relative risk aversion (CRRA). Then

(3) $$\frac{d\ln c_t}{dt} = -\frac{1}{\gamma}(h_t + \rho - r) + \frac{h_t}{\gamma}c_t^{\gamma}V_t$$

h_t is taken from life tables, and so varies with age, race, and sex.

Equations such as (3) have been estimated many times based on macro data or on PSID food spending. An important difference here is that we will have panel data on household consumption. A second important difference is that in our model variation in mortality risk, h_t, identifies γ whereas in macro estimations it is identified by variations in r. Because variation in r is accompanied by changes in the macro-economy, it is difficult to know whether any change in $d\ln c_t/dt$ is due to a change in r or some other macro change.

Couples Model.

Because the couples' model is not well know we will give additional background to it.[6]

A couple chooses a consumption path to maximize expected lifetime utility, which includes the utility from consumption while both are alive, the utility from the wealth that a surviving spouse would inherit, and the utility from wealth that the surviving spouse would bequeath outside of the household.

$$\int U(C_t)e^{-\rho t}a_t dt + \int M(w_t)e^{-\rho t}p_{m_t}dt + \int F(w_t)e^{-\rho t}p_{f_t}dt + \int V(w_t)e^{-\rho t}m_t dt$$

$U(\cdot) =$ utility function of the couple

$\rho =$ subjective time rate of discount of the couple

$a_t =$ probability that both spouses will be alive at t

$M(\cdot) =$ widower's utility of wealth

$p_{m_t} =$ probability density that the husband becomes a widower at t; that is, the probability that the wife dies at t and the husband is still alive at t.

$F(\cdot) =$ widow's utility of wealth.

$p_{f_t} =$ probability density that the wife becomes a widow at t; hat is, the probability that the husband dies at t and the wife is still alive at t.

5 Previous estimation has found no evidence that wealth change is related to the number of children, which should be a good test of the bequest motive (Hurd, 1989).

6 See Hurd (1999) for a derivation and discussion of the couples' model.

$V(\cdot) =$ utility from true bequests (bequeathed outside the household).

$w_t =$ bequeathable wealth at t

$m_t =$ probability density that the surviving spouse dies at t.

This objective function has the same structure as in the singles model: the couple gets utility from consumption and utility from "bequests." The utility from bequests is in three parts: future utility of the widower, future utility of the widow, and future utility from true bequest.

The maximization is subject to the same conditions as in the singles model.

The solution is

(4) $$\frac{dU_t}{dt} = U_t(h_t + \rho - r) - (M_t\phi_t + F_t\mu_t)$$ where

$U_t =$ marginal utility of consumption by the couple

$h_t =$ the couple's mortality risk (the probability density that one of them will die at t given that neither has died before t)

$M_t =$ widower's marginal utility of wealth

$F_t =$ widow's marginal utility of wealth

$\phi_t =$ mortality risk of the wife (the probability density that the wife will die at t given that she has survived to t)

$\mu_t =$ mortality risk of the husband

This equation can be rewritten as

(5) $$\frac{d\ln C_t}{dt} = -\frac{1}{\gamma_t}(h_t + \rho - r) + \frac{1}{\gamma_t}\Omega_t$$

where $\Omega_t = M_t\phi_t + F_t\mu_t$ which is the expected marginal utility of wealth in the event a spouse dies. This equation has the same form as the solution to the singles problem: the first term depends on the mortality risk of the couple and the marginal utility of consumption when both spouses are alive; the second term depends on the marginal utility of wealth in the event of "death" of the couple, that is, either of the spouses dies.

Data

Our data come from the Health and Retirement Study (HRS). The HRS is a multipurpose household survey among the elderly population in the United States. It is collected by the Institute for Social Research (ISR) at the University of Michigan. At baseline, respondents were selected from the community-dwelling population (including retirement homes but not nursing homes). In subsequent waves, respondents were followed even if they entered an institution. The initial HRS wave took place in 1992. The sample consisted of individuals born in 1931-41 (age 51-61 in 1992), plus their spouses (of any age). In 1993, a companion survey ("Assets and Health Dynamics Among the Oldest-Old," AHEAD) interviewed respondents born in or before 1923 (age 70+ in 1993), plus their spouses of any age. Barring attrition or death, the 1992 respondents were re-interviewed in 1994 and 1996; the 1993 respondents were re-interviewed in 1995. The two cohorts were merged into a single sample with a single questionnaire in 1998, at which time the sample was augmented with respondents born in 1924-30 ("Children of the Depression Age," CODA) or 1942-47 ("War Babies," WB). With provided sampling weights, the resulting 1998 sample was representative of the non-institutionalized American population born in or before 1947 (age 51 or older in 1998). The HRS was re-interviewed in 2000, 2002 and 2004, and in 2004 a new cohort (1948-53) was added to rejuvenate the sample and to make it again representative of the population 51 or over. The total sample size is around 22,000 individuals. Table 1 shows the various cohorts and their interview schedule.

The HRS queries a wide range of topics: *demographics* (age, education, education of parents, marital status and history, veteran status); *family structure* (lots of information on household members, children, siblings, and parents); *health conditions* (whether the respondent has ever seen doctor for various conditions, vision and hearing, pain, smoking, drinking, weight, height, depression); *cognition* (self-assessment of memory, cognitive test questions); *health care utilization and costs* (health insurance, out-of-pocket expenses, other expenses with varying detail across waves, whether anyone helped pay, Medicare number); *health status* (ADLs/IADLs, whether gets help; for each helper, gender, frequency, hours, whether paid, out-of-pocket costs, whether anyone helped pay); *housing* (type, cost, special services); *job status* (employment status/history, earnings, hours, pension coverage, type, expected benefits, rights from previous jobs); *expectations* (chances of giving/receiving major financial assistance, inheritance, entering nursing home; major medical expenses; inflation; longevity); *income* (many sources and total, assistance from others, will); *net worth* (many asset types, IRA/Keogh, stocks, bonds, bank, trusts); *insurance* (Medicare, Medicaid, other, whether managed, coverage and payments for long term care, life insurance, beneficiaries), etc. In addition to these core questions, asked of the entire sample, there were additional topical modules asked of randomly assigned sub-samples.

Consumption and Activities Mail Survey

The HRS has fielded seven waves as of 2004, and the 2006 wave is now in the field. It has high-quality income and wealth measures, but the core survey has just a partial measure of total consumption.[7] In October 2001 the Consumption and Activities Mail Survey (CAMS), a self-administered mail survey of consumption and time-use, was sent to 5000 respondents randomly chosen from the entire age range of the HRS.[8] Only one person per household was chosen. About 3800 HRS households responded, so CAMS I is a survey of the spending of 3800 households, and the time use of 3800 persons in those households.[9]

Section A of CAMS asks about time-use in 32 categories. Section B asks about the purchase of six large durables during the past year and 26 categories of nondurables. With a few minor exceptions the categories were chosen to match CEX categories so as

[7] Food purchases, food eaten outside the home or delivered to the home, rent, utilities, real estate taxes and out-of-pocket medical expenses in several major categories. These total about 40-50% of total consumption as measured in the CEX.

[8] When we will refer to the HRS we mean all cohorts, including what was formerly called AHEAD, CODA and WB. In 2001 the age range was approximately 54 or older.

[9] The only discernable pattern of unit nonresponse is a small increase in nonresponse among the very old.

to facilitate a comparison with CEX.[10] An innovation in the CAMS questionnaire was to allow the respondent to choose the time frame for reporting on the purchases in many of the categories. For example, rent is typically paid monthly. Automobile insurance may be paid quarterly, semi-annually, or annually. Clothing purchases may be made monthly by some but only rarely by others. Food is purchased weekly or monthly.

As shown in Table 2, a beneficial consequence of this questionnaire design is that item nonresponse is much lower than it is for typical financial variables such as the components of wealth or income where it can be as high as 40%. Furthermore, in the spending categories with the highest rate of nonresponse, we have information from the HRS core that we can use for imputation. For example, rent has almost the highest rate of nonresponse. However, we have responses in the HRS about homeownership which we can use to impute rent. Of the 506 who were nonrespondents to the rent query, 420 owned a home in HRS 2000.[11] We believe we can confidently impute zero rent to these households. Similarly among nonrespondents to the question about homeowners insurance and who owned a home with mortgage in 2000, 69% reported that their insurance was included in their mortgage payment. Apparently they did not respond in CAMS because they had already included that amount in the mortgage report. Based on these and similar imputations that use HRS core data to provide household-level information, 64% of CAMS respondents are complete reporters over all 32 categories of spending.[12]

We have imputed the remaining missing data to account for the partial reports by assigning means within categories. Because of the low rates of item nonresponse, the amount of consumption data imputed as a fraction of the total is considerably lower than measures of income or wealth in the HRS.

Based on these imputations, we have compared CAMS totals over the 32 spending items with CEX totals based on published tables. The totals are almost identical: among households aged 55 or over, the CAMS total is $32,900 and the CEX total is $32,800.

In October 2003 the same 5,000 households were sent CAMS II.[13] It has substantially the same structure as CAMS wave 1.

We note that the LCM concerns consumption whereas our data are on spending. Our measure of spending is the sum of annualized spending on nondurables and services, and annual spending on big-ticket items. At the household level the difference between consumption and spending for durables could be substantial, but at the population level the flow of new purchases of durables will average to the flow of consumption in steady-state. For example, the average consumption of durables by age will be approximately the same as average spending on durables by age. A lengthening of the time between purchases leading to a decline by age in quality-adjusted consumption will show up in the data as an age decline in spending on durables.

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[10] Several small categories were dropped and a few were merged to reduce respondent burden.

[11] We also used HRS 2002 to check for change in homeownership.

[12] All of these imputations converted nonresponses to zero values as in the example of rent.

[13] With the following exceptions: the respondent refused an interview in the HRS 2002 core; the respondent died; the respondents had diabetes and was part of a subset that was randomly allocated to a mail questionnaire about compliance with diabetes treatment. The HRS has generated weights to account for the diabetes allocation.

Results

We first present results for singles because the life-cycle model makes simple predictions about consumption levels and changes for singles in the absence of a bequest motive.

Figure 1 shows averages of real wealth change. We calculate these averages in two-year panels based on HRS 1996-1998,1998-2000, and 2000-2002 by taking mean or median wealth in a second wave relative to the previous wave, and then averaging the changes over the three panel changes. We do this to reduce the influence of macro shocks that would obscure anticipated or desire wealth change. The mean changes in particular show a very consistent pattern of decline rates of wealth increase, turning negative in the age band 75-79. This is a pattern that would be predicted by the life-cycle model where the interest rate is fairly high relative to the subjective time rate of discount.

Figure 2 is based on income from the HRS 2002 wave, which pertains to income in 2001, and on spending from CAMS wave 1 which pertains to spending in 2001. On the left side of the graph the top line is are pre-tax income and the bottom line is post-tax income. The middle line is spending. It is clear that if we want to find saving rates as the difference between income and spending we must take taxes into account. The lines show that spending tracks post-tax income fairly close up to age band 70-74, but beginning at 75 spending exceeds income. This is shown more clearly in Figure 3, which has saving rates out of after-tax income. Saving rates become sharply negative at ages 80 or greater. This is consistent with the negative wealth changes shown in Figure 1.

Table 3 has real spending levels and spending change among singles in CAMS waves 1 and 2. Thus among those 60-64 spending increased by about 4.9% at the mean between the waves. The pattern shows relatively constant spending both at the mean and median until 80 when spending change becomes quite negative. This would be predicted by the LCM in the absence of a strong bequest motive: at advanced old age, mortality risk, h_t, becomes large so that the consumption path will have a negative slope as in (3) with $V_t = 0$. Because the slope of the consumption path is fairly responsive to mortality risk, the risk aversion parameter γ is fairly small: In (3) if γ is large the slope will be small even as h_t varies.

Although the CAMS spending data are very reasonable on average, they have considerable measurement error at the household level. Then if we directly estimate the Euler equation

$$\ln c_{t+1} - \ln c_t = -\frac{1}{\gamma} h_t + \frac{1}{\gamma}(r - \rho)$$

the nonlinear transformation of c will result in a non-classical error term. Therefore, we estimated γ from averages over age bands using average mortality risk for the singles in the age band. Based on this our estimate of γ is 1.39 and $r - \rho$ is 0.034.

We can compare these estimates with the CAMS consumption change data and also with a model estimated over wealth change data. Figure 4 shows three simulated consumption paths beginning at age 60 and normalized to 100 at that age. The line labeled “CAMS data” uses the annualized rates of the change in mean consumption shown in Table 3. Those rates are assumed constant within each age band. The line labeled "CAMS model" comes from the estimated γ of 1.39 and $r-\rho$ of 0.034. The line labeled RHS model comes from estimates of (3) based on wealth change data from the Retirement History Survey (Hurd, 1989). In those estimations γ was 1.12 and $r-\rho$ was 0.019. The three curves are broadly similar and depict a life-cycle model with little if any bequest motive.

Table 4 shows spending change for couples. Because of small samples in the age band 85 or over, we aggregated into one age band 80 or over. Only in the top age band is there decline in consumption with age, and even that is confined to the mean. The life-cycle model for couples is much more complex than the model for singles and cannot be analytically solved. So we have not way of determining analytically whether these results are in conformity with the LCM. Therefore we use results based on a model estimated by Gan, Gong and Hurd (2006). They estimated the couple's model over the wealth data from waves 2 and 3 of AHEAD. In their estimations γ for the couple is 1.2 and ρ is 0.02.

Figure 5 shows the simulated consumption path by couples based on changes in mean consumption (Table 3) and on the estimated model of Gan, Gong and Hurd. Both show slowly increasing consumption at a rate of about 0.3% per year until 80. At that age the predictions diverge. In that the simulations are based on very different data, we interpret the paths to be remarkably similar.

Conclusion

We have shown three types of results: wealth change, saving rates and consumption change. They are all broadly consistent both qualitatively and quantitatively. Singles begin to dissave whether measured by wealth change or saving rate after about the age of 75. Consumption begins to decline also at about that age. The consumption paths found by assuming that observed changes in consumption in an age band persist, are similar to consumption paths found from fitting a model to wealth change data. We conclude that the patterns are consistent with a simple life-cycle model where the only uncertainty is mortality.

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Table 1
HRS interview schedule

	HRS 1931-1941	AHEAD 1923 or earlier	CODA 1924-1930	WB 1942-1947
1992	X			
1993		X		
1994	X			
1995		X		
1996	X			
1998	X	X	X	X
2000	X	X	X	X
2002	X	X	X	X
2004	X	X	X	X

Table 2
Item response rates in CAMS wave 1

Spending Category	
Big ticket item purchases	
Automobile or truck	96.4
Refrigerator	96.6
Washing machine/dryer	97.8
Dishwasher	97.7
Television	97.2
Computer	97.4
Payments	
Mortgage	92.2
Homeowner's or renter's insurance	88.7
Property tax	88.8
Rent	86.7
Electricity	92.4
Water	89.7
Heating fuel for the home	86.3
Telephone, cable, internet	93.9
Vehicle finance charges	86.2
Vehicle insurance	92.0
Health insurance	91.1
Spending	
Housekeeping, yard supplies	93.8
Home repairs and maintenance	93.9

Food and beverages	94.8
Dining/drinking out	94.8
Clothing and apparel	94.2
Gasoline	93.4
Vehicle maintenance	93.3
(Non-)Prescription medications	94.5
Health care services	93.7
Medical Supplies	92.1
Trips and Vacations	94.7
Tickets to movies, events etc.	95.0
Hobbies	94.2
Contributions	94.5
Cash or gifts to family/friends	94.2

Table 3
Total spending and two-year spending change (percent). Singles. Panel

	N	Mean			Median		
		Wave1	Wave 2	percent change	Wave1	Wave 2	percent change
60-64	214	28758	30162	4.88	23879	23379	-2.10
65-69	210	25627	25486	-0.55	19803	20622	4.14
70-74	150	26328	27119	3.00	21813	22267	2.08
75-79	163	24766	24498	-1.08	19362	19990	3.24
80-84	146	28098	22205	-20.97	22362	19988	-10.62
85 or over	134	28291	23792	-15.90	20097	19380	-3.56

Table 4
Total spending and two-year spending change (percent). Couples. Panel

	N	Mean			Median		
		Wave 1	Wave 2	Percent change	Wave 1	Wave 2	Percent change
60-64	723	48,463	50,077	3.33	38,551	41,192	6.85
65-69	671	43,113	43,578	1.08	35,122	35,473	1.00
70-74	500	43,152	42,713	-1.02	33,241	33,815	1.73
75-79	289	40,753	42,495	4.28	33,176	35,173	6.02
80 or over	207	39,704	36,458	-8.18	28,550	29,223	2.36

Figure 1

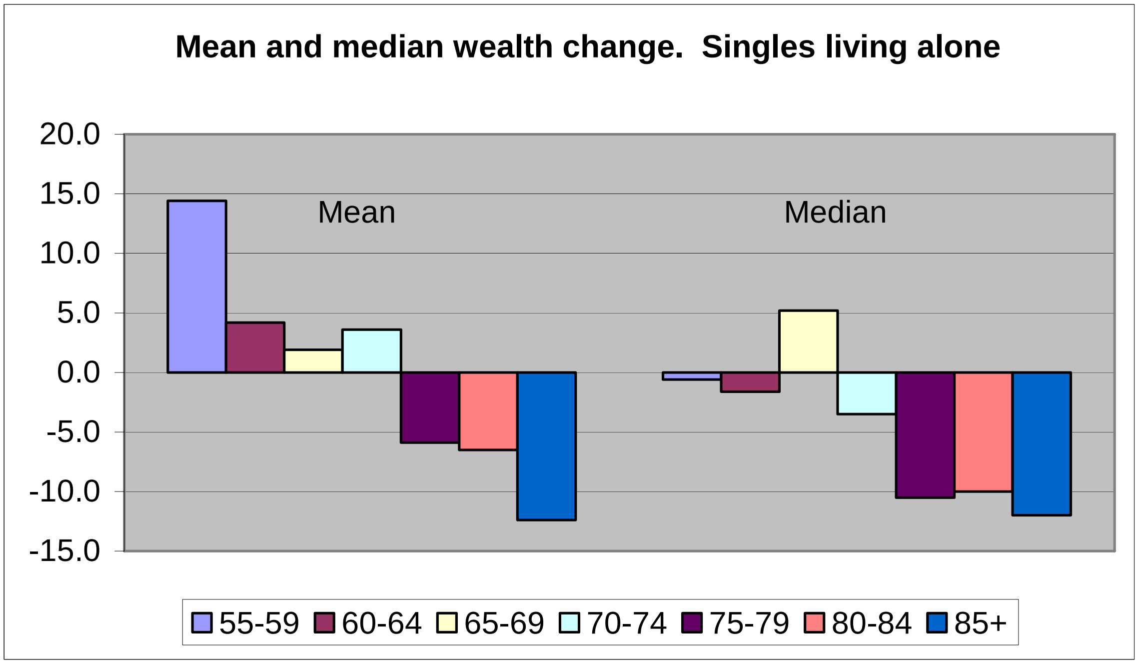


Figure 2

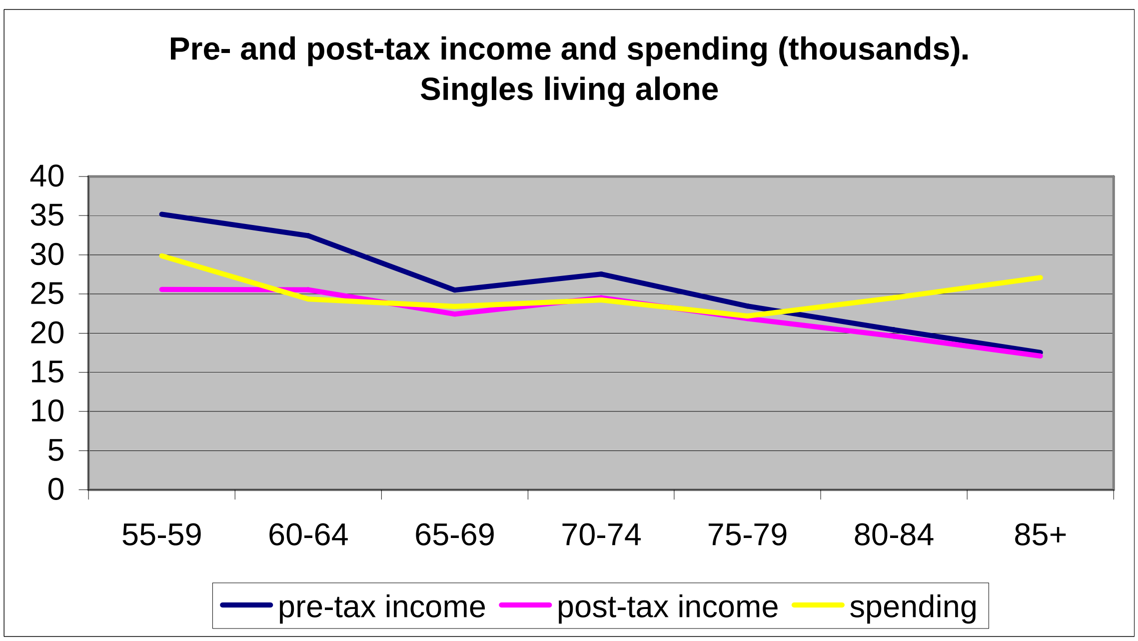


Figure 3

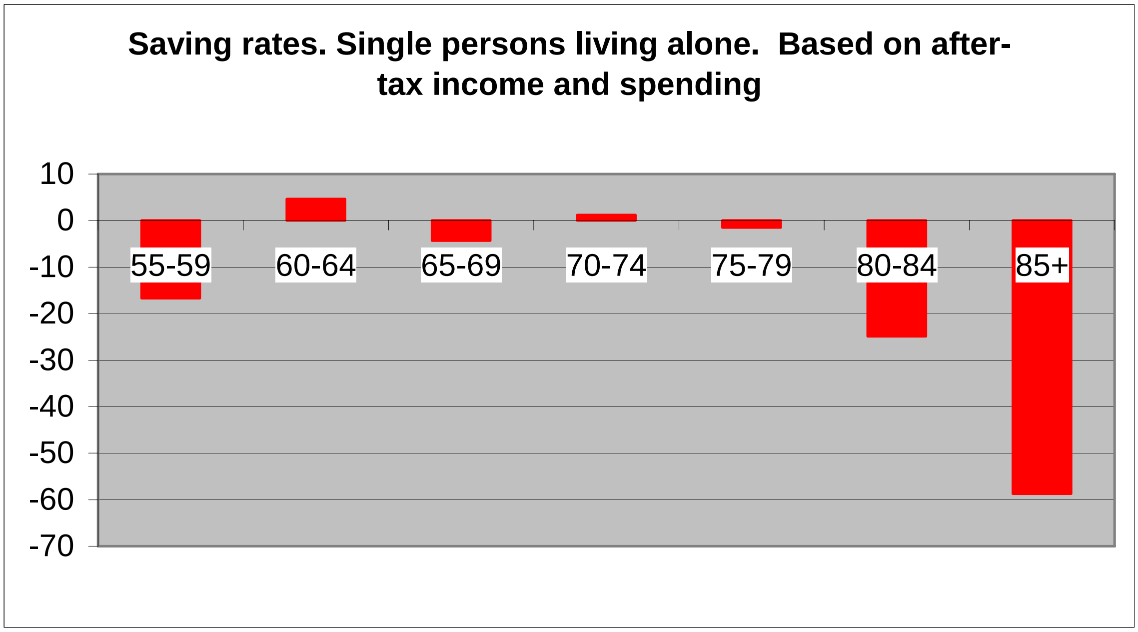


Figure 4

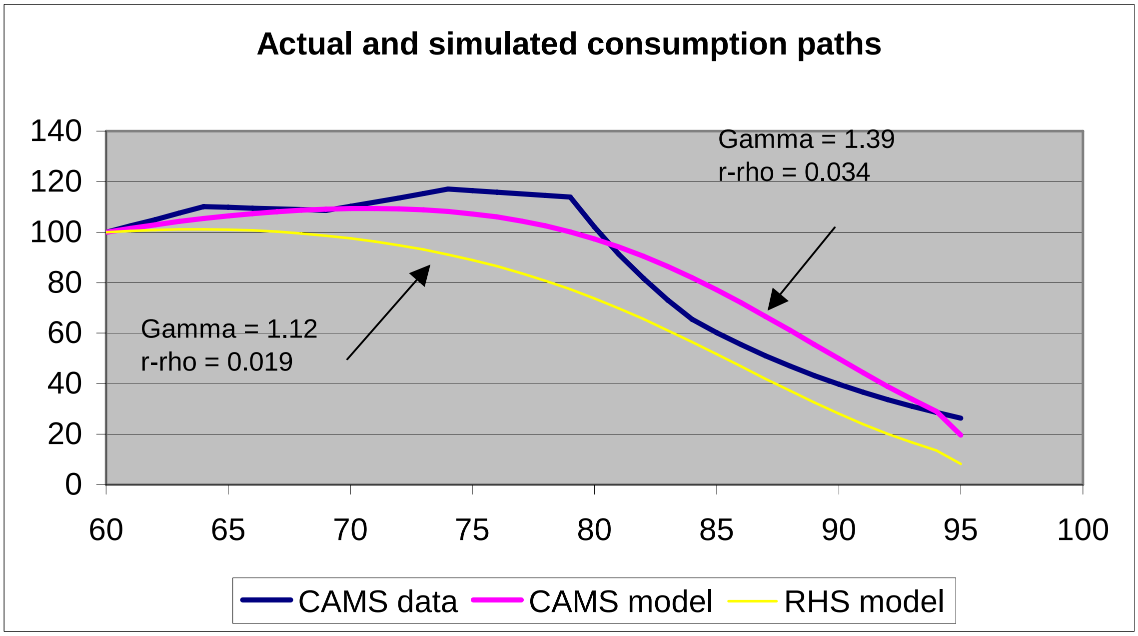
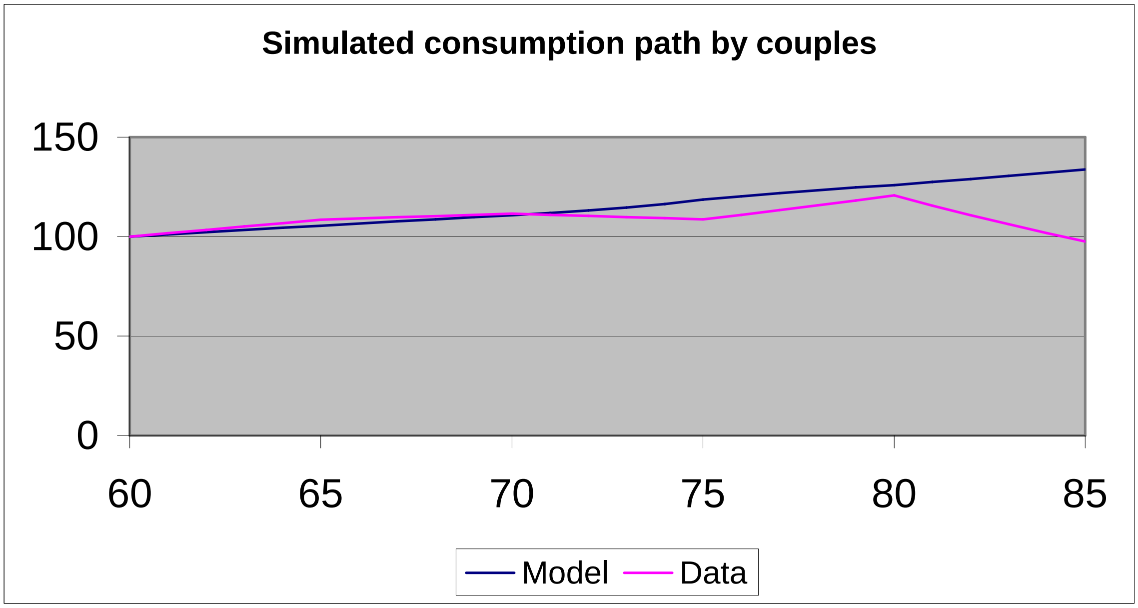


Figure 5


Simulated consumption path by couples
150
100
50
0
60
65
70
75
80
85
Model
Data