THE ACCUMULATION OF HOUSEHOLD WEALTH OVER THE LIFE-CYCLE: A MICRODATA ANALYSIS*

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In this paper, I investigate the validity of the Modigliani–Brumberg (M–B) model as an explanation of the variation of wealth holdings among households. The model as such, even with the inclusion of estimates of household lifetime earnings, explains only a minute portion of the variation in household wealth. Indeed, for certain groups such as non-white, rural residents, and the low educated, the coefficients of the regression model are insignificant. Moreover, when the top wealth holders are removed from the sample and when non-cash financial and business assets are eliminated from the household portfolios, the explanatory power of the M–B model increases markedly. Essentially, the validity of life-cycle wealth accumulation models must be restricted to the white, urban, educated middle classes and their accumulation of housing, durables, and cash. The rich have very different motives for saving and very different sources of saving, while the poor do not earn sufficient income over their lifetime to accumulate any non-negligible wealth.

A life-cycle model was first proposed by Modigliani and Brumberg (11) as a process explaining aggregate savings behavior. Since the article's appearance in 1954, the vast majority of the empirical work on the life-cycle model has investigated the model's implications concerning savings behavior. Indeed, in the last decade or so the life-cycle model has gone virtually unchallenged as a theory of savings.[1]

The life-cycle model, as first proposed by Modigliani and Brumberg (M–B) and in later variants such as that of Ando and Modigliani [1] or of Tobin [19], is also a theory of household wealth accumulation. Indeed, the life-cycle model as such also constitutes a theory of the distribution of household wealth, albeit a primitive one. Although some work has been done to test the model's implications concerning the distribution of household wealth using aggregate data, as will be seen below, this aspect of the model has gone virtually untested using microdata. This deficiency is particularly surprising since it is precisely the process of household wealth accumulation that is presumed to explain the aggregate savings behavior of the economy. Any failure of the life-cycle model to account for the

*Earlier versions of this paper were presented at the Eastern Economics Association meetings in Boston, May 1979, and at the International Association for Research in Income and Wealth meetings in Pörtschach, Austria, in August 1979. I would particularly like to thank Thad Mirer and Anthony Pellechio for their comments and John Kambhu for his research assistance.

[1]One notable exception is a recent article by White [20], who used aggregated household balance sheet data to test whether several variants of the life-cycle model accurately predict the aggregate savings observed in the U.S. economy. Using a wide range of parametric values, White simulated the savings behavior of the population given its actual demographic composition and income flows. She concluded that the assumption that households save for future consumption does not account for the observed aggregate personal saving. At best, the simulated values are approximately 60 percent of the actual. Also, see her article for references to previous life-cycle tests using aggregate data.

household distribution of wealth would then cast serious doubt on the model's validity as an explanation of savings behavior.

The central focus of the paper will be to investigate the accumulation of wealth over the life-cycle. (To call such an investigation a "test" would be to presume too much, since the M–B model and its successors fully acknowledge the role of other factors beside age as determinants of the distribution of household wealth.) Part I will present the M–B model and its implications concerning the distribution of household wealth. Part II will review previous findings on the aggregate distribution of household wealth by age group and results of simulation models of the life-cycle hypothesis. Part III will present regression results of a life-cycle model run on the full sample and selected demographic groups using recently available microdata. In Part IV, several estimates of lifetime earnings will be made and introduced into the life-cycle model. In Part V, the model will be applied to different segments of the wealth distribution and different sets of assets. Part VI will present some concluding remarks.

I. The M–B Life-Cycle Model

In the M–B model, the exclusive motive for saving and wealth accumulation is to provide sufficient resources for consumption in the retirement years. For simplicity, the model assumes that the individual receives the same labor earnings each year he is working and that he optimally desires to have the same level of consumption in every period of his life. Moreover, the model assumes that total lifetime earnings are consumed (that is, net worth is zero at death) and, for simplicity, that the interest rate is zero.[2] The savings pattern that results is a constant savings rate until retirement age and a constant dissavings rate thereafter. The resulting life-cycle net worth profile is shown in Figure 1. Net worth rises with age until retirement age and then declines.

A variant of the M–B model, which also focuses on savings out of labor earnings as the major source of household wealth, was developed by Tobin [19] in 1967. Tobin retains the assumption of a level stream of lifetime consumption and zero net worth at death but adds in the possibility that a family may incur debt early in the life-cycle to purchase the housing and durables necessary to establish a household. Moreover, the model adds in a positive rate of return on assets (and debt) as a factor affecting household wealth accumulations. The resulting wealth pattern is also shown in Figure 1 for contrast. The family dissaves in its early years, saves during its middle years to repay its debt and to accumulate for retirement, and dissaves again in its later years. Thus, in this variant, net worth may start off negative, increase and become positive, and then decline again after retirement.[3]

[2]This latter assumption implies that savings occur only out of labor earnings. This assumption is dropped later in the Ando–Modigliani [1] model. Even with the new assumption of a constant rate of return on assets over time, the age–wealth profile remains an inverted "U".

[3]It should be emphasized that this variant is proposed by Tobin as only one possible life-cycle wealth profile. Empirically, there is no aggregate or microdata evidence to support this particular profile. One reason for the absence of negative net worth at early ages that Tobin stresses is liquidity constraints imposed by the absence of perfect capital markets.

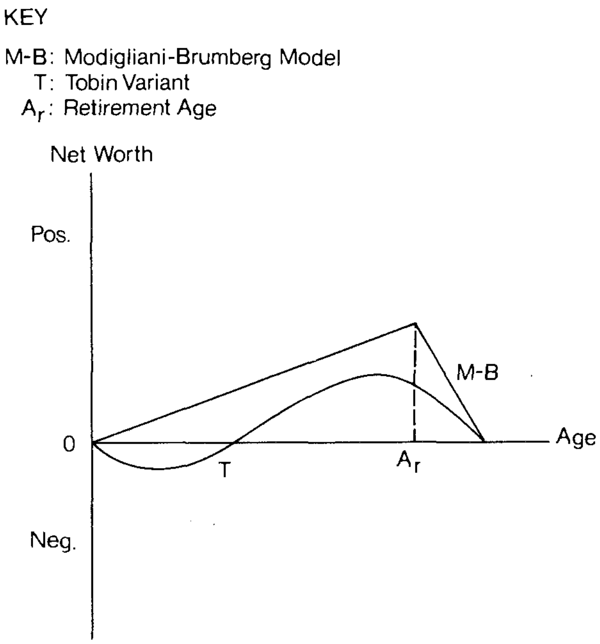

Figure 1. Life-cycle wealth profiles.

The major issue addressed in this paper is how well the M–B model and its later variants account for the distribution of household wealth. There are four other major factors besides age that can account for differences in household wealth holdings. The first factor is differences in lifetime earnings and its distribution over time across households. The second is differences in savings rates both over time and across households. The third is differences in rates of return on asset holdings, including capital gains, both over time and across households. The last is differences in gifts, inheritances, and other transfers of wealth received by households. That part of the variation in household wealth not explained by age should be almost completely explained by these other four factors. The empirical section of the paper will ascertain how important the life-cycle process is relative to these four omitted factors in explaining the variation in household wealth. A crude attempt will be made, with the data on hand, to estimate one of these omitted variables—namely, lifetime earnings up to current age—and this variable will also be introduced into the regression equation.

II. Some Aggregate and Simulation Results

Before proceeding to the microdata results, I will first review some previous work on aggregate age–wealth profiles, which is summarized in Table 1. In the Lydall [8] study, there was a steady rise in mean net worth with age until age 64

TABLE 1
MEAN WEALTH (NET WORTH) BY AGE GROUP[a]

	Age of Head	Mean Net Worth	Ratio to Age 25–34
A. U.K., 1953[b]	18–24	£ 40	0.13
	25–34	320	1.00
	35–44	760	2.38
	45–54	1,160	3.63
	55–64	1,200	3.75
	65+	1,180	3.69
B. U.S., 1953[c]	24	$ 4,000	0.49
	33	8,200	1.00
	43	14,800	1.80
	53	21,100	2.57
	63	22,500	2.74
C. U.S., 1962[c]	33	$ 9,800	1.00
	42	16,200	1.65
	52	22,600	2.31
	62	20,900	2.13
	72	22,400	2.29
D. U.S., 1969[d]	18–24	$15,400	0.67
	25–34	23,100	1.00
	35–44	31,100	1.35
	45–54	45,500	1.97
	55–64	56,800	2.46
	65+	52,100	2.26

[a]Net worth figures in current prices.
[b]*Source*: Lydall [8], Table 9, p. 144.
[c]*Source*: Lansing and Sonquist [6], adapted from Tables 3 and 7, pp. 39 and 50.
[d]*Source*: Wolff, [21], Table 4.

and then a slight decline in the last age group. In both sets of estimates provided in the Lansing and Sonquist [6] study, mean wealth generally increased with age, even between the cohorts aged 62 and 72 in 1963. In the Wolff [21] data reported in an earlier article, mean wealth rose steadily with age until age 64 and then decreased. Thus, as predicted by the M–B model, mean wealth increased with age until age 64 in all four studies and fell after age 64 in the Lydall and Wolff data, though not in the Lansing and Sonquist figures for 1962.

There are also two sets of simulation results that pertain to the life-cycle model. The first was developed by Atkinson [2], who introduced inheritance in order to account for the failure of the earnings–savings life-cycle models to explain the upper tail of wealth distribution in Britain. With no inheritance and wealth due to only accumulated savings, a simple life-cycle model would predict that the top ten percent of the population would hold only about twenty percent of total wealth, well below the actual concentration ratio. With the added assumption that the top ten percent of the distribution receive equal inheritance shares, the simulated top ten percent would hold at most 30 percent of total individual wealth, considerably below the actual 60 to 70 percent.

Oulton [13] generalizes Atkinson's model to allow the age distribution, individual's earnings function, and the rate of return on assets to vary. Substituting the distribution of earnings estimated from the actual British data into his model and assuming no inheritance, Oulton computes a maximum coefficient of variation of wealth of 0.75, which is less than the smallest observed value of 3.98. Moreover, Oulton computes that in order for the variation in the rates of return on assets to explain the remaining inequality in wealth, the standard deviation of the rate of return would have to be approximately double its mean value, which is most unlikely. The remaining residual in explaining the inequality of wealth would be due to the distribution of inheritances, whose inequality would be quite large.

III. Microdata Tests of the Life-Cycle Model

A specially-created synthetic dataset, called the MESP database, was used for the empirical analysis. The database consists of a cross-section sample of 63,457 households in the U.S., with demographic, income, and balance sheet information as of the end of 1969.[4] Table 2 shows the full national balance sheet for the household sector in 1969. Of the full set of assets the following are included in the MESP database (and also starred in Table 2):

(1) owner occupied home;
(2) other real estate;
(3) consumer durables;
(4) currency and demand deposits;
(5) time and savings deposits;
(6) government securities (excluding state and local bonds), corporate and foreign bonds, mortgages, and other financial securities;
(7) corporate stock;
(8) farm business equity;
(9) unincorporated non-farm business equity.

All liability entries are included. Net worth or wealth in the MESP database is defined as the sum of the included assets less total debt.[5]

Since in this paper I am interested only in the general explanatory power of the life-cycle model and its applicability to different segments of the population,

[4]See Wolff [22] and [23] for a full description of the MESP database. See Ruggles and Ruggles [15] and Ruggles, Ruggles, and Wolff [16] for a description of the statistical matching technique used in the database's creation. For those familiar with the MESP database, it should be noted that the variable age was an "exact match" variable, meaning that all observations synthetically matched have the same age of the head of household. Moreover, in [16] a test of the matching technique was provided in which regressions were run on the same set of variables in a synthetically created dataset as on an actual (Census) dataset. There were no statistically significant differences in the estimated coefficients.

[5]Not present in the asset list are the following: (1) household inventories (semi-durables); (2) state and local government securities; (3) cash surrender value of insurance; (4) pension rights; and (5) Social Security entitlements. See the conclusion for a discussion of the possible biases their omission might produce in the results.

I will use several functional specifications to replicate the M–B age–wealth profile.[6] The first is a parabolic function on age:

$$W_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^2 + u_i \tag{1}$$

where W_i is individual household wealth, A_i is the age of the head of household and u_i is a random error term. The M–B model would predict:

$$\beta_1 > 0, \qquad \beta_2 < 0.$$

This model was run on a randomly selected 1 in 10 sample of the MESP database (sample size of 6,316).[7] The results are shown in line 1 of Table 3. Both coefficients are in the predicted direction and significant at the one percent level. Moreover, the function reaches a maximum at age 62, close to what the model would predict.

[6]Technically speaking, the major difficulty in using the MESP sample to test the M–B model is that the model refers to the behavior of a family over time (longitudinal behavior), whereas the data are cross-sectional. Under the simplifying assumptions of the M–B model, this difference does not matter, since the interest rate is zero and earnings are constant over time and *between cohorts.* If any of these assumptions is violated, then the regressions run on the MESP sample do not, strictly speaking, provide a valid test of the life-cycle model.

All is not completely lost. Shorrocks [17], for example, has shown that under fairly general conditions allowing for differences in earnings between cohorts, a cross-sectional inverted U-shaped age–wealth profile is necessary but not sufficient to ensure an inverted U-shaped age–wealth profile over the lifetime. Thus, rejection of an inverted U-shaped cross-sectional age–wealth profile is sufficient to reject the M–B lifetime model, though the converse is not rrue.

Mirer [10] suggests one way to adjust the cross-sectional regression for differences in cohort earnings. However, the adjustment he proposes is inadequate once it is allowed that the interest rate is different from zero and that earnings increase with age for a given cohort in addition to allowing for differences in cohort earnings. To show this, let us concern ourselves with the under-65 population and let us assume that everyone starts work at age 20, retires at age 65, and has a constant savings rate s. (It is now necessary to drop the assumption of a constant lifetime consumption pattern.) Define:

A = age −20

W_A = wealth (now) for those in cohort A

E_{tA} = earnings at time t for cohort A

r = interest rate (constant over time)

g = rate at which earnings grow for a given cohort over time (the same for each cohort)

h = rate at which starting earnings increase between successive cohorts.

Then:

$$W_A = \int_0^A sE_{tA}\, e^{r(A-t)}\, dt = s\, e^{rA} \int_0^A E_{tA}\, e^{-rt}\, dt.$$

Moreover, $E_{tA} = E_{0A}\, e^{gt}$ and $E_{0A} = E^*\, e^{(45-A)h}$.
Then:

$$W_A = \frac{sE^*\, e^{45h}}{r-g}\left(e^{(r-h)A} - e^{(g-h)A}\right) \qquad \text{if } g \neq r$$

$$= sE^*\, e^{45h}\, e^{(r-h)A} \cdot A \qquad \text{if } g = r.$$

Here, the slope of the cross-sectional profile depends crucially on the parameters r, g, and h and an investigation of this will be left for a future paper.

[7]A few cases were eliminated because of errors.

TABLE 2

AGGREGATE NATIONAL BALANCE SHEET OF HOUSEHOLD WEALTH FOR THE U.S., 1969, BY ITEM

(Billions of Current Dollars)

Item	Value	
I. Assets	3612.8	
A. Tangible Assets	1220.3	
1. Owner-occupied Housing*		635.0
2. Other Real Estate*		175.8
3. Automobiles*		89.5
4. Other Consumer Durables*		227.3
5. Inventories		92.7
B. Financial Assets	2392.6	
1. Demand Deposits and Currency*		104.9
2. Time and Savings Deposits*		381.4
3. Federal Securities*		101.4
4. State and Local Government Securities		34.8
5. Corporate and Foreign Bonds, Mortgages, Open Market Paper, Other Instruments*		85.6
6. Corporate Stock*		635.9
7. Farm Business Equity*		218.1
8. Unincorporated Non-farm Equity*		314.5
9. Trust Fund Equity		132.8
10. Insurance and pension reserves		383.1
II. Liabilities	450.2	
1. Mortgage Debt*		276.6
2. Consumer Credit*		121.1
3. Other Debt*		52.5
III. Net Worth	3162.6	

*Included in the MESP database.

Source: Estimates prepared by Raymond Goldsmith in Ruggles [14]. Consumer durables were split into autos and others from Bureau of Economic Analysis worksheets provided by John Musgrave.

Since the M–B model predicts an asymmetrical age–wealth profile, three other polynomial functions in A were tried:

$$W_i = \beta_0 + \beta_1 A_i^2 + \beta_2 A_i^3 + u_i \tag{2}$$

$$W_i = \beta_0 + \beta_1 A_i^2 + \beta_2 A_i^4 + u_i \tag{3}$$

$$W_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^3 + u_i \tag{4}$$

For each of these functions the coefficient predictions are the same as above. All the estimated coefficients are in the predicted direction and significant at the one percent level (lines 2 through 4 of Table 3). Moreover, all three of the asymmetrical forms have higher t-ratios than the symmetrical form, lending further support to the M–B model. The age at maximum wealth are respectively 63, 64, and 62. A fifth equation was also tried which exactly replicates the M–B wealth profile:

$$W_i = \beta_0 + \beta_1 A_i + \beta_2 (A_i D_i) + \beta_3 D_i + u_i \tag{5}$$

TABLE 3

BASIC LIFE-CYCLE REGRESSIONS RUN ON THE FULL SAMPLE

Equation	Dependent Variable	Constant	Independent Variables: A	A^2	A^3	A^4	D	$(A \cdot D)$	R^2	R_a^2
1	W	−62,508	3870** (3.3)	−31.4** (2.7)	—	—	—	—	0.003	0.003
2	W	−7,855	—	50.9** (3.8)	−0.537** (3.4)	—	—	—	0.003	0.003
3	W	156	—	29.1** (4.1)	—	−0.00350** (3.4)	—	—	0.003	0.003
4	W	42,997	2439** (3.8)	—	−0.211** (2.8)	—	—	—	0.003	0.003
5	W	−21,857	1492** (4.8)	—	—	—	115,044 (1.2)	−2146 (1.6)	0.004	0.003

Key: W: wealth; A: age; D: dummy variable, which equals 1 if $A \geq 65$; R^2: coefficient of determination; R_a: adjusted R^2.

Notes: t-ratios shown in parentheses. Sample size = 6,316.

*Significant at 5 percent level (2-tailed test).

**Significant at 1 percent level (2-tailed test).

where D is a dummy variable which equals one if age is 65 or over and equals zero otherwise. The coefficient predictions on β_1 and β_2 are the same. Though the signs are in the predicted direction, only the first coefficient estimator is significant.[8]

Despite the high t-ratios, particularly in forms (2) and (3), the R^2 for these two forms and the other three are extremely low. This indicates that the M–B life-cycle savings model explains only a minute part of the overall variation of wealth across households. This "unexplained" variation is due to the four factors discussed above. However, it is quite possible that the model performs better for certain subgroups of the population than for others, and that part of the unexplained variation in wealth across all households is due to differences in behavior (like savings) among demographic groups.

I next ran equation (2), which yielded the most significant results, on selected subsamples of the population. The first division is by the race of the head of household. Since race is an unchanging characteristic of an individual, these two samples remain almost mutually exclusive over the life-cycle.[9] The result for whites and Orientals, which comprise almost 90 percent of the total sample, are almost identical to those for the whole sample (see Table 4). The results for blacks and other races show much lower (in absolute value) and insignificant coefficients on A^2 and A^3, suggesting that the life-cycle wealth accumulation model is inappropriate for non-whites.

The next division is between urban and rural residents. This classification is not mutually exclusive since some households do move between urban and rural areas over their lifetime. Despite this, the differences are striking. The coefficients on A^2 and A^3 for urban residents are very significant, whereas those for rural residents are insignificant. Moreover, the R^2 and the adjusted $-R^2$ are considerably higher for the urban group. The results indicate that the life-cycle model is also inappropriate for rural residents.

The third division is by level of schooling. This is a permanent characteristic of individuals after they enter the labor force, except for a small group who acquire advanced education after starting to work. The differences are quite striking between these groups. For all the schooling groups except college graduates, the coefficient values on A^2 and A^3 are quite close to those for the full sample, but all the coefficients except one are insignificant. For the college graduate group, the coefficients on A^2 and A^3 are considerably higher in absolute value and both are significant at the one percent level. Moreover, the R^2 and the adjusted $-R^2$ are considerably higher for college graduates than for any other demographic group. These results strongly suggest that the life-cycle model is

[8]A regression was also run on the model

$$W_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^2 + \beta_3 A_i^3 + u_i.$$

The Tobin variant would predict:

$$\beta_1 < 0, \qquad \beta_2 > 0, \qquad \beta_3 < 0.$$

Though the signs of the coefficient estimators were in the predicted direction, none of them were statistically significant.

[9]The only exception is from inter-racial marriage, which may cause *individuals* classified in one household race category to switch into the other.

TABLE 4

REGRESSION OF WEALTH ON AGE FOR SELECTED DEMOGRAPHIC GROUPS

	Independent Variables					
Demographic Group	Constant	A^2	A^3	R^2	R_a^2	N
Full Sample	−7,855	50.9** (3.8)	−0.537** (3.4)	0.003	0.003	6,316
Whites, Orientals	−9,436	54.4** (3.7)	−0.574** (3.3)	0.003	0.003	5,617
Other Racial Groups	6,061	22.1 (1.8)	−0.237 (1.6)	0.007	0.004	702
Urban, Suburban Residents	658	38.1** (4.8)	0.390** (4.1)	0.008	0.008	4,633
Rural Residents	−32,193	87.7 (1.2)	−0.953 (1.7)	0.003	0.001	1,543
Schooling Under 12 Years	−10,384	48.5 (1.9)	0.502 (1.7)	0.002	0.001	2,866
12 Years Schooling	−2,558	41.9* (2.3)	−0.446 (1.9)	0.004	0.003	1,791
Schooling 13–15 Years	−8,374	52.7 (1.8)	−0.540 (1.5)	0.010	0.008	788
Schooling 16 or more Years	−30,168	96.0** (3.4)	−1.045** (3.9)	0.020	0.018	868

Key: A: age; R^2: coefficient of determination; R_a^2: adjusted R^2; N: sample size.

Notes: Households are classified according to the demographic characteristics of the head of household.

*Significant at 5 percent level (2-tailed test).

**Significant at 1 percent level (2-tailed test).

more appropriate for the college graduate group than for any other demographic group.[10]

IV. THE INCLUSION OF LIFETIME EARNINGS

Of the four additional factors mentioned in Part I that account for the unexplained variation in household wealth, the one for which it is possible to make crude estimates with MESP is lifetime earnings (up to current age). If it is assumed that savings rates are constant across households and over time (and, by implication, independent of earnings), then accumulated wealth up to current age

[10]See Lansing and Sonquist [6] for a similar finding. The same regression was also run within the following five occupational groups: (1) professional, technical, managerial, and administrative workers; (2) clerical and sales workers; (3) craftsmen; (4) operatives; and (5) service and unskilled workers. There are two problems with this classification. First, many workers will switch occupational class over their lifetime. Second, only a small portion of those over 65 recorded their last occupations. However, the results do show significant inverted U-shaped life-cycle wealth profiles for group (1), professionals and administrators, and group (3), craftsmen, with the profile considerably more "humped" for the former. Moreover, when the regression was run on only professional and technical workers, the coefficients on A^2 and A^3, their t-values, and the R^2 and adjusted $-R^2$ were all higher than for group (1).

should be proportional to lifetime earnings to current age (assuming a zero interest rate). The revised specification becomes:

$$W_i = \beta_0 + \beta_1 A_i^2 + \beta_2 A_i^3 + \beta_3 LE_i + u_i \tag{6}$$

where LE_i is lifetime earnings up to current age for household i.

I used standard human capital earnings functions to estimate lifetime earnings (see Mincer [9], for example). Since I observed earnings for each household at one point in time, 1969, it was necessary to make these estimates using cross-sectional data rather than longitudinal data. The procedure was as follows. First, the sample was partitioned by the following characteristics:

(a) Race: Whites and orientals (whites, for short)/Others;
(b) Residence: Urban and Suburban (urban, for short)/Rural;
(c) Occupation: Professionals/Farmers/Others;
(d) Education: 0–11 years/12 years/13–15 years/16 or more years.

Second, within each of these subgroups the current annual wage and salary earnings of the head of household was regressed on A and A^2 to obtain the average lifetime earnings profile for this group. (The results for urban whites are shown in Table 5.) Third, computations were performed from the regression results to estimate the following measures of lifetime earnings (LE) for each racial, residential, schooling, and occupational group. In all, twelve different estimates were made. Among the first six, the difference is the choice of the average rate g at which the age–earnings profile increases between age cohorts:[11]

$$LE_i = \int_{A_0}^{A_c} f(A)\, e^{-g_i(A_c - A)}\, dA \tag{7}$$

for $g_0 = 0$, $g_1 = 0.01$, $g_2 = 0.02$, $g_3 = 0.03$, $g_4 = 0.04$, $g_5 = 0.05$, where LE_i is the estimate of total accumulated lifetime earnings from the end of schooling (A_0) to current age (A_c) and $f(A)$ is the *cross-sectional* estimated age-earnings profile for each demographic and schooling group. The range in the value of g was deliberately chosen to be quite large in order to gauge the sensitivity of the resulting regression estimates to the choice of g. In the other estimates of lifetime earnings, we adjusted the estimate for each *individual* head of household according to how his current earnings deviated from the average (regression line) earnings for his age and demographic group:

$$LEA_i = \frac{E}{f(A_c)} \cdot LE_i \qquad \text{for } i = 0, 1, 2, 3, 4, 5 \tag{8}$$

where E is current earnings.[12]

[11]The variable g essentially measures the rate at which mean earnings increase over time. If mean earnings were constant over time, then earnings for a given age cohort would follow the cross-sectional function $f(A)$ over time as the cohort aged. However, for $g > 0$, earnings for a given cohort would change from both a movement along $f(A)$ and from a shift in the whole function by g.

[12]Here, it is assumed that the ratio between individual and average earnings is maintained throughout the life-cycle. Alternative forms for the computation of lifetime earnings are given in Mincer [9], Lillard [7], and Moss [12]. Mincer regressed the logarithm of earnings on A and A^2 to obtain a life-cycle earnings profile. Lillard regressed dollar earnings on A, A^2, and A^3. Moss used cohort averages and longitudinal data for his estimates. Experiments using Mincer's approach and Lillard's approach produced very little difference in lifetime earnings estimates.

TABLE 5
THE COMPUTATION OF LIFETIME EARNINGS FOR URBAN WHITES

Sub-Group		Regression on Current Earnings					Earnings	
		Independent Variables						Undiscounted
Occupation	Schooling	Constant	A	A^2	R^2	n	Age at Maximum	Lifetime (to age 65)
Professionals	0–11	9,975	97.8 (0.4)	−1.65 (0.8)	0.018	181	30	$522,907
	12	−3,169	752.8* (2.5)	−8.11* (2.5)	0.024	255	46	592,781
	13–15	−13,747	1214.3** (5.0)	−12.25** (4.6)	0.101	255	50	609,103
	16+	−21,467	1648.9** (5.6)	−16.70** (5.0)	0.079	470	49	676,491
Others	0–11	−4,553	674.9** (8.5)	−7.60** (9.0)	0.087	898	44	426,408
	12	−231	515.5** (5.9)	−5.72** (5.5)	0.049	711	45	482,112
	13–15	−4,440	687.9** (4.4)	−7.34** (4.0)	0.097	254	47	456,820
	16+	−23,847	1703.9** (4.1)	−17.92** (3.8)	0.062	103	48	573,220

Key: A: age; R^2: coefficient of determination; n: sample size.
Note: Dependent variable is total annual wage and salary earnings in 1969 for head of household. Undiscounted lifetime earnings is the integral under the age–earnings curve from last year of schooling to age 65.
*Significant at the 5 percent level (2-tailed test).
**Significant at the 1 percent level (2-tailed test).

Regressions of wealth on A^2, A^3, and the various measures of lifetime earnings were run on the full sample and various demographic subsamples. The most significant results are for urban whites (shown in Table 6). The results for the unadjusted lifetime earnings forms (LE_0 to LE_5) are all very similar in both coefficient values, significance levels, and R^2 value. The coefficients on A^2 and A^3 are all insignificant (and, indeed, the signs are opposite to the predicted direction), the coefficient on LE is in the predicted direction and extremely significant, and the R^2 statistics are all about 0.015, considerably higher than the form without lifetime earnings included (cf. Table 4). The regression results for the adjusted lifetime earnings forms (LEA) are almost as uniform as those with the unadjusted estimates. The signs on A^2 and A^3 are all in the predicted direction, and in three cases the coefficient estimates of A^2 are significant at the 5 percent level. The coefficients of LEA are all in the predicted direction and significant at the one percent level. The R^2 statistics are all about 0.015 or about five times the R^2 statistics of the same regression on the urban white sample with the lifetime earnings variable excluded. Thus, the inclusion of the LEA variable increases the

TABLE 6

REGRESSIONS OF WEALTH ON AGE AND LIFETIME EARNINGS ESTIMATES FOR URBAN WHITES

Lifetime Earnings Estimate	Constant	Independent Variables A^2	A^3	$LE(LEA)$	R^2	R_a^2
$LE_0(g=0.0)$	15,298	−15.23 (0.8)	0.069 (0.4)	0.180** (3.3)	0.014	0.013
$LE_1(g=0.01)$	19,792	−25.30 (1.2)	0.207 (1.0)	0.221** (3.7)	0.015	0.014
$LE_2(g=0.02)$	20,636	−31.09 (1.5)	0.306 (1.4)	0.256** (3.7)	0.015	0.014
$LE_3(g=0.03)$	20,628	−34.64 (1.6)	0.376 (1.6)	0.290** (3.9)	0.015	0.114
$LE_4(g=0.04)$	19,970	−36.23 (1.7)	0.419 (1.7)	0.321** (3.9)	0.015	0.015
$LE_5(g=0.05)$	18,853	−36.20 (1.7)	0.440 (1.8)	0.348** (4.0)	0.015	0.015
$LEA_0(g=0.0)$	18,028	21.92 (1.8)	−0.219 (1.4)	0.485** (4.4)	0.016	0.016
$LEA_1(g=0.01)$	19,473	21.56 (1.7)	−0.204 (1.3)	0.526** (4.3)	0.016	0.015
$LEA_2(g=0.02)$	11,084	22.77 (1.8)	−0.205 (1.3)	0.522** (4.2)	0.016	0.015
$LEA_3(g=0.03)$	818	24.91* (2.0)	−0.220 (1.4)	0.481** (3.9)	0.015	0.014
$LEA_4(g=0.04)$	−883	27.37* (2.2)	−0.241 (1.5)	0.413** (3.5)	0.014	0.013
$LEA_5(g=0.05)$	−1,637	29.63* (2.4)	−0.262 (1.7)	0.336** (3.0)	0.014	0.013

Key: A: age; $LE(LEA)$: lifetime earnings; R^2: coefficient of determination; R_a^2: adjusted R^2.

Note: Sample size is 3,134. Heads of household under 65 with no current earnings were assigned an adjustment factor of 1. All household heads 65 or over were implicitly assigned an adjustment factor of 1. Moreover, those household heads with no recorded occupation were assigned the average lifetime earnings for their schooling group.

t-statistics are shown in parentheses.

*Significant at the 5 percent level (2-tailed test).

**Significant at the one percent level (2-tailed test).

overall explanatory power of the M–B model but at the cost of reducing the significance levels of the age variables. These results thus strongly suggest that the primary reason that wealth follows an inverted U-shaped age profile is not the M–B explanation that households save for retirement and then consume out of their savings after retiring but rather that earnings follow an inverted U-shaped profile. Thus, wealth increases with age until about 60 in the cross-sectional profile primarily because earnings increase with age and families save according to what they earn.

V. Adjusting the Sample for Size of Wealth and Type of Assets

A regression of the squared residual on size of wealth yielded R^2 in excess of 0.80 for each of the equations in Table 6. Not surprisingly, this indicates that most of the unexplained variation in wealth holdings is attributable to the failure of the life-cycle model to account for the large wealth holdings. One way to adjust for this is to eliminate the top percentiles from the sample.[13] This was done, and the results of re-running equation (6) on the bottom 99 percentiles (eliminating the top percentile), the bottom 95 percentiles, and the bottom 90 percentiles are shown in Table 7. (The lifetime earnings form LEA_3 was chosen, because it

TABLE 7

Regressions of Wealth on Age and Lifetime Earnings for Urban Whites on Selected Sub-Samples

	Independent Variables					
Sample	Constant	A^2	A^3	LEA_3	R^2	R_a^2
All	818	24.91* (2.0)	−0.220 (1.4)	0.481** (3.9)	0.015	0.014
Bottom 99 percent	4,174	19.63** (6.4)	−0.194** (5.0)	0.190** (6.1)	0.065	0.064
Bottom 95 Percent	6,508	13.30** (7.5)	−0.136** (6.0)	0.144** (6.3)	0.075	0.074
Bottom 90 Percent	6,289	11.67** (9.3)	−0.130** (8.1)	0.086** (6.7)	0.078	0.077

Key: A = age; LEA_3 = lifetime earnings; R^2 = coefficient of determination; R_a^2 = adjusted R^2.

Note: Sample size is 3,134. Household heads with no current earnings were assigned an adjustment factor of 1, and those with no recorded occupation were assigned the average lifetime earnings for their schooling group.

t-statistics are shown in parentheses.

*Significant at the 5 percent level (2-tailed test).

**Significant at the 1 percent level (2-tailed test).

yielded the best results in Table 6.) The results are quite striking. First, when the top one percent is eliminated, the R^2 jumps from 0.015 to 0.065. When the top five percent is removed, the R^2 becomes 0.075; and when the top 10 percent is eliminated, the R^2 becomes 0.078. Second, as more and more of the top of the distribution is removed, the significance level of the coefficients on A^2 and A^3 increases. Third, as the top percentiles are chopped off, the absolute value of the constant term and the coefficients on A^2 and A^3 drop, and the life-cycle profiles

[13] An alternative is to regress the logarithm of wealth on age and lifetime earnings, since algebraically this has the effect of reducing the dependent variable wealth proportionately more for large values than for small values. This was done, with the result that the R^2 climbed to 0.10 and the t-statistics all exceeded 7.5 for the urban white sample. Though this procedure certainly improves the fit of the life-cycle model, there is no theoretical rationale at this stage of analysis for using the logarithm form of wealth instead of wealth as the dependent variable.

become more and more "plausible." The age at maximum wealth declines from 73 for the whole sample to 69 then 66 and then 61. The life-cycle model thus seems quite inappropriate for accounting for the acquisition of wealth by the very wealthy.

Because certain asset holdings, such as stocks, bonds, and business equity, are so heavily concentrated in the hands of the rich (see Wolff [22], for example), another way of adjusting for size of wealth is to divide the household portfolio into its constituent components and analyze the life-cycle accumulation pattern of each. This I did by segmenting household net worth into the following component parts:

(1) value of owner-occupied housing;
(2) current market value of durables;
(3) cash and demand deposits;
(4) savings and time deposits;
(5) stocks and bonds;
(6) investment real estate and business equity (including farm);
(7) household debt.

Each component was then regressed on age for the full sample. Two forms were tried: first, the symmetrical form (A, A^2) and, second, the asymmetrical form (A^2, A^3). The better fit for each is shown in Table 8. The differences are striking. The equations with own home, durables, cash and demand deposits, and household debt as dependent variables have much higher R^2 statistics than the other three components. Indeed, the R^2 for the durables equation is almost 100 times greater than the R^2 for the stocks and bonds equation. Moreover, the best fit form for these four components is the symmetrical (A, A^2) one, while the asymmetrical form (A^2, A^3) is the best fit for the other three components. In addition, the significance levels of the age coefficients for these four components are much greater than the significance levels of the age coefficients for the other three wealth components.

As a result of these differences, I divided total household wealth into two parts. The first part, which I call "life-cycle wealth," is defined as the sum of own home, durables, and cash and demand deposits less mortgage debt. The second part, which I call "capital wealth," is defined as the sum of savings and time deposits, stocks and bonds, and investment real estate and business equity less other debt.[14] Life-cycle wealth W_1 was then regressed on age. The R^2 statistic is 0.064, about twenty times as great as that for the total wealth regression. The t-ratios on the age coefficients are both above 18.0, and the estimates indicate age 55 as the age of maximum life-cycle wealth. The regression of capital wealth on age yielded an R^2 of 0.002, much lower t-ratios, and an age of maximum capital wealth of 64. The regression of total wealth on age yields slightly higher R^2 and t-ratios than the capital wealth regression but considerably lower R^2 and t-ratios than the life-cycle wealth regression. The age at maximum total wealth is 63, quite close to that for capital wealth. It is apparent that the regression results for total

[14] Additional experimentation showed, not surprisingly, that the size of mortgage debt follows age rather closely, whereas other household debt is virtually unrelated to age.

TABLE 8

FULL SAMPLE REGRESSION OF WEALTH COMPONENT ON AGE

Dependent Variable	Independent Variables					
Wealth Component	Constant	A	A^2	A^3	R^2	R_a^2
Own Home	−12,051	968.8** (16.5)	−9.46** (16.3)	—	0.041	0.041
Durables	1,344	198.9** (18.7)	−2.28** (21.7)	—	0.099	0.099
Cash & Demand Deposits	54	53.93** (5.4)	−0.301** (3.1)	—	0.029	0.029
Savings & Time Deposits	1,110	—	4.13 (1.5)	−0.035 (1.1)	0.001	0.001
Stocks & Bonds	−11,677	—	24.09** (2.9)	−0.247 (1.9)	0.001	0.001
Real Estate Plus Business Equity (incl. farm)	−1,927	—	14.55** (3.2)	−0.159** (3.0)	0.002	0.002
Total Household Debt	−3,333	427.3** (9.3)	−4.50** (10.0)	—	0.017	0.016
Life-Cycle Wealth (W_1)	−8,137	838.9** (19.9)	−7.68** (18.4)	—	0.064	0.064
Capital Wealth (W_2)	−12,4100	—	41.8** (3.2)	−0.434** (2.8)	0.002	0.002
Total Wealth (W)	−7,855	—	50.9** (3.8)	−0.537** (3.4)	0.003	0.003

Key: A = age; R^2 = coefficient of determination; R_a^2 = adjusted R^2; W_1 = own home + durables + cash and demand deposits − mortgage debt; W_2 = savings and time deposits + stocks and bonds + investment real estate and business equity (including farm) − other debt.

Note: Sample size = 6,316.

t-ratios are shown in parentheses.

*Significant at 5 percent level (2-tailed test).

**Significant at 1 percent level (2-tailed test).

wealth are much more strongly influenced by its capital wealth component than by its life-cycle wealth component.[15]

The two wealth components were then each regressed on the age variables within selected demographic groups (Tables 9 and 10). A comparison with Table 4 indicates that the W_1 regressions have considerably higher t-statistics on the age variables and R^2 statistics that are approximately ten times as great as the corresponding total wealth (W) regression by demographic group. Moreover, all the coefficients in the W_1 regressions are significant at the one percent level (and in the predicted direction). However, the rank order on goodness of fit remains the same for the W_1 regressions as for the W regressions. The life-cycle accumulation process of life-cycle wealth is still a more appropriate model for whites than for

[15]This is perhaps not too surprising, since in the MESP sample, total capital wealth as a fraction of total household wealth is 74 percent.

TABLE 9

REGRESSION OF LIFE-CYCLE WEALTH (W_1) ON AGE BY DEMOGRAPHIC GROUPS

	Independent Variables					
Demographic Group	Constant	A	A^2	R^2	R_a^2	N
Full sample	−8,137	838.9** (19.9)	−7.68** (18.4)	0.064	0.064	6,316
Whites, Orientals	−9,253	911.3** (19.9)	−8.38** (18.6)	0.071	0.071	5,617
Other Racial Groups	1,427	248.2** (3.3)	−2.06** (2.8)	0.026	0.024	702
Urban, Suburban Residents	−10,247	950.1** (18.5)	−8.67** (17.0)	0.077	0.077	4,633
Rural Residents	−1,389	478.3** (6.7)	−4.39** (6.3)	0.029	0.028	1,543
Schooling Under 12 Years	−1,964	447.3** (8.5)	−3.75** (7.6)	0.029	0.029	2,866
12 Years Schooling	−8,612	843.5** (11.5)	−7.47** (9.9)	0.097	0.096	1,791
Schooling 13–15 Years	−15,457	1214.0** (8.9)	−10.85** (7.5)	0.150	0.147	788
Schooling 16 or More years	−35,803	2246.5** (13.8)	−20.55** (12.1)	0.231	0.230	868

Key: A = age; R^2 = coefficient of determination; R_a^2 = adjusted R^2; N = sample size.

Note: Households are classified according to the demographic characteristics of the head of household.

*Significant at 5 percent level (2-tailed test).

**Significant at 1 percent level (2-tailed test).

non-whites, though, for the first time, the coefficients on age are significant for non-whites. The process is considerably more descriptive of urban residents than of rural ones, and of more highly educated groups than of less educated ones. Indeed, the R^2 statistic reaches 23 percent for college graduates. The W_2 regressions, on the other hand, have uniformly lower R^2 and t-statistics on the age variables (except for the rural group) than the total wealth regressions, but the rank order across demographic group remains identical.[16]

The lifetime earnings variable LEA_3 was then added to the regression specification. Results are shown for urban whites (Table 11). The R^2 statistic is extremely high for the W_1 regression, at 0.16, more than ten times the R^2 statistic for the comparable total wealth regression (Table 6), and the t-values on the age coefficients are more than seven times those for the total wealth regression. The R^2 statistic for the W_2 regression, on the other hand, is considerably lower than the total wealth regression, as are the t-values. This indicates that the accumulation of life-cycle wealth is much more strongly influenced by labor earnings than the accumulation of capital wealth.

[16]For the rural group, farm ownership, a portion of capital wealth, is a very important asset, and the change in its value tends to follow the life-cycle pattern.

TABLE 10

REGRESSION OF CAPITAL WEALTH (W_2) ON AGE BY DEMOGRAPHIC GROUP

Demographic Group	Independent Variables: Constant	A^2	A^3	R^2	R_a^2	N
Full Sample	−12,410	41.8** (3.2)	−0.434** (2.8)	0.002	0.002	6,316
Whites, Orientals	−13,965	44.6** (3.0)	−0.463** (2.7)	0.002	0.002	5,617
Other Racial Groups	656	19.5 (1.6)	−0.208 (1.4)	0.005	0.002	702
Urban, Suburban Residents	−3,148	27.4** (3.5)	−0.268** (2.9)	0.006	0.006	4,633
Rural Residents	−38,602	83.2 (1.8)	−0.903 (1.7)	0.002	0.001	1,543
Schooling Under 12 Years	−15.217	43.4 (1.7)	−0.447 (1.6)	0.001	0.001	2,866
12 Years Schooling	−6,091	31.7 (1.7)	−0.332 (1.5)	0.003	0.002	1,791
Schooling 13–15 Years	−9,987	37.6 (1.3)	−0.369 (1.0)	0.007	0.004	788
Schooling 16 or More Years	−26,816	69.1* (2.5)	−0.735* (2.1)	0.013	0.010	868

Key: A = age; R^2 = coefficient of determination; R_a^2 = adjusted R^2; N = sample size.

Note: Households are classified according to the demographic characteristic of the head of household.

*Significant at 5 percent level (2-tailed).

**Significant at 1 percent level (2-tailed test).

TABLE 11

REGRESSION OF LIFE-CYCLE WEALTH AND CAPITAL WEALTH ON AGE AND LIFETIME EARNINGS FOR URBAN WHITES

Dependent Variable	Independent Variables: Constant	A	A^2	A^3	LEA_3	R^2	R_a^2
W_1	−11,895	1,022** (15.1)	−9.93** (13.9)	—	0.126** (15.2)	0.159	0.158
W_2	−2,620	—	13.0 (1.0)	−0.075 (0.5)	0.363** (3.0)	0.010	0.009

Key: W_1 = Life-Cycle Wealth; W_2 = Capital Wealth; A = Age; LEA_3 = Lifetime Earnings; R^2 = Coefficient of determination; R_a^2 = Adjusted R^2.

Note: Sample size is 3,134. Household heads with no current earnings were assigned an adjustment factor of 1, and those with no recorded occupation were assigned the average lifetime earnings for their schooling group.

t-statistics are shown in parentheses.

*Significant at the 5 percent level (2-tailed test).

**Significant at the 1 percent level (2-tailed test).

VI. Conclusions and Speculations

How adequate is the life-cycle savings model in accounting for the observed differences in household wealth? Before answering this question, let me respond to three possible objections that might be made to the results presented in the preceding three parts of the paper. The first objection may be that the M–B model is a longitudinal model whereas the empirical results are based on a cross-sectional sample. However, as mentioned above, it is possible to show that under some fairly general conditions the M–B model will imply an inverted U-shaped cross-sectional age–wealth profile, *whereas the converse is not true.* Thus, an inverted U-shaped cross-sectional profile becomes a necessary though not sufficient condition to show the existence of an inverted U-shaped longitudinal age–wealth profile.

The second objection may be that the MESP sample is constructed with synthetically matched datasets and this may bias downward the covariance among non-matching variables with respect to their true (population) covariance. However, experiments performed by running regressions on a true sample and on a synthetically created one showed no statistically significant differences in the estimated coefficients. Moreover, even if such a downward bias existed, the relative success of the M–B model *across demographic groups* would remain valid unless there were a systematic relation between this bias and demographic characteristics.

A third objection may be raised because of the omission of certain assets from the MESP sample (see Table 2). One set of omitted assets, consisting of household inventories, insurance reserves, and pension reserves, might be *a priori* suspected of closely following a life-cycle accumulation pattern. Thus, their exclusion would bias downward the explanatory power of the M–B model. But since this group comprises only 13 percent of total household assets, the bias would be relatively small. The other set, comprising 5 percent of total assets, includes state and local government securities and trust fund equity, assets which one might suspect on *a priori* grounds to be unrelated to a life-cycle wealth accumulation process. Their exclusion would thus likely have the opposite impact. A word should also be said about the exclusion of "Social Security" wealth, since it has recently figured so prominently in the debate on *aggregate savings behavior* (see Feldstein [4] or Kotlikoff [5], for example). From the standpoint of the individual, his contribution to the Social Security system is to him a *claim on future income* and thus may affect his current savings decision. From the standpoint of society now, all real disposable wealth is already fully included in the tangible and financial portfolios of the household, business, and government sectors. Thus, like human capital which also represents a claim on future income but is not a title to or a claim on disposable assets now (except in a slave society), Social Security wealth should not be included within the household portfolio.

With these qualifications in mind, it is possible to conclude that as a general model explaining the distribution of household wealth, the M–B life-cycle hypothesis is grossly inadequate. Moreover, by implication, as an explanation of aggregate savings the M–B model is likewise inadequate. Though in the simple regression model the coefficients on the two age variables are both significant at the one percent level with the predicted signs, the variation in household wealth explained by the model is only 0.3 percent. Even with the inclusion of lifetime income in the regression specification, the goodness of fit of the model increases to only 1.5 percent for urban whites.

Moreover, it is also possible with the results to say for which groups the M–B life-cycle model is, in fact, inappropriate. This would include non-whites, rural residents, and non-high-school graduates, who all show insignificant coefficients on the age variables in the regression results. Indeed, the group for which the life-cycle model gives by far and away the best fit is college graduates. (Perhaps, not surprisingly, the proponents of the life-cycle model are all college graduates.) Moreover, the results indicate that as an explanation of how the wealthy, particularly the top 5 percent, became that way, the model likewise fails, as Atkinson found. Dividing the household portfolio into two components gives further insights into the validity of the model. If one considers the household accumulation of housing, durables, and cash and demand deposits less mortgage debt, than the model performs brilliantly for the full sample and all demographic groups. When lifetime earnings is added to the specification, the R^2 reaches 0.16 for the urban white sample. If one considers the household accumulation of savings and time deposits, stocks and bonds, investment real estate and business equity less consumer debt except mortgages, then the model's explanatory power for the white sample and every demographic group is minute. This is perhaps not too surprising, since these assets are heavily concentrated in the hands of the rich.

The M–B life-cycle model's validity must then be limited to the white, urban, educated middle class accumulation of the standard forms of middle class wealth–housing, durables, and cash. This is the group that saves out of its labor earnings to accumulate housing, durables, and liquid assets for its retirement years. Two other distinct groups emerge from this study. The first is the poor, as represented in this study by non-whites, for whom there is virtually no accumulation of wealth over the life-cycle, except perhaps in the form of durables. The reason is that the poor do not receive sufficient earnings in order to save for accumulation. The other group is the very wealthy—the top five percent or so—who do not become wealthy by saving out of their labor earnings. Rather they most likely acquire their wealth from inheritance and gifts and in the form of stocks, bonds, real estate, and business equity.[17] The growth of their wealth—"capital wealth"—is tied into the overall growth of the real capital stock of the economy. The likely effect that age has on the wealth of this class is that the likelihood of inheritance increases with age (cf. Lansing and Sonquist [6], p. 65). Generously, one could conclude that the life-cycle model is reasonably descriptive of the wealth behavior of about the middle two-thirds of the U.S. population. But, because of the tremendous concentration of household wealth in the hands of the rich, the model may account for the acquisition of about a quarter of household wealth.

The results of this investigation have several important implications regarding the proper modeling of the size distribution of household wealth. Most

[17]Blinder [3], for example, reports from the 1960–61 Survey of the Financial Characteristics of Consumers that 57 percent of consumer units in the highest income class (over $100,000) inherited a "substantial" portion of their wealth.

importantly, a proper model must be a *three-class model*, each class with its own generating mechanism. The first class is the capitalist class, whose wealth takes the form of "capital wealth", whose motive for accumulation is to build up large estates, and whose mechanism of transmission is through inheritance. The actual generating mechanism of the wealth held by this class must be tied into the growth of the real aggregate capital stock of the productive sectors (cf. Stiglitz [18], for example). The second class, which may be called the "primary working class," is one whose wealth takes the form of "life-cycle wealth" and whose motivation for accumulation is both for the consumption of the services from housing and durables and for retirement. This class accumulates wealth by saving out of labor earnings, and the distribution of wealth among this class depends on age as well as differences in earnings, savings rates, and rates of return. The third class, which may be called the "secondary work force," is one whose lifetime income is too low to permit any significant accumulation, except in the form of durables.

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