DIVIDING CAPITAL ACCUMULATION INTO ITS LIFE CYCLE AND INTERGENERATIONAL TRANSFER COMPONENTS

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A quarter of a century has passed since Franco Modigliani and Richard Brumberg presented their life cycle theory of saving. During this period numerous articles either invoking or testing the life cycle theory have been written. Despite this research effort, the importance of pure life cycle or "hump" savings to the process of aggregate capital accumulation remains unresolved. Estimates of the importance of life cycle savings are extremely divergent. A competing view of the accumulation process is that intergenerational transfers whether in the form of inter-vivos gifts or bequests at death, explain the bulk of aggregate wealth holdings. Understanding the accumulation process is important the efficient mix of wage, interest income, gift, and estate taxation would presumably be different if intergenerational transfers explained 95% of accumulation than if they explained 5%. A finding that the great proportion of accumulation arises from intergenerational transfers would lend support to economic models involving intergenerationally overlapping utility functions. The implications of such models for the burden of the national debt, the impact of social security on savings, and the incidence of taxation are markedly different than for the life cycle model.[1] If intergenerational transfers are found to be the major element determining accumulation, economists would presumably shift their research attention to studying the transfer process. Questions such as the importance of the distribution of lifetime resources to lifetime transfers and wealth accumulation would naturally be raised.

This paper attempts to directly estimate the fraction of aggregate private wealth that may reasonably be ascribed to life cycle accumulation. The residual fraction may then be attributed to intergenerational transfers. Previous attempts to decompose accumulation into its life cycle and transfer components have primarily relied on simulation models. In these analyses a hypothetical life cycle economy is posited; predictions forthcoming from these models of total savings and wealth holdings for different parameter values are then compared with the national aggregates to determine whether the life cycle model, by itself, can explain these aggregates.[2] Rather than specify a hypothetical life cycle utility function, our technique is simply to analyze actual historical data to determine whether current wealth holdings can be explained solely by historic life cycle savings. We are thus posing the following counter factual. Suppose there were no intergenerational transfers of any kind in the U.S. economy, then the current wealth holdings of U.S. citizens would simply reflect savings out of labor income accumulated over their life times. Total U.S. wealth holdings would equal the sum over all persons of each person's accumulated life cycle assets. Given detailed information on the labor earnings, consumption, and the rate of return for each individual at each age in his or her past, one could carry out the life cycle wealth computation for the entire economy. If we had such detailed information, it would be easy to check whether total U.S. wealth holdings could be explained simply by life cycle accumulation.

Obviously such detailed individual specific data is not available. However, historical data for the United States on aggregate earnings, aggregate consumption, rates of return, age-earnings, and age-consumption profiles may be used to carry out this life cycle asset computation. In this paper we treat individuals of each sex within an age cohort as if they were identical. We estimate for males and females age cohorts in 1974 the average excess of earnings over consumption experienced by members of that age-sex cohort during each of their adult years in the past. These differences are then accumulated up to 1974 using historical net nominal interest rates. The total over all age-sex cohorts of these accumulated life cycle assets are then compared with the 1974 value of total U.S. private net worth.

There are three major sources of potential error in our procedure; one involves biases arising from treating individuals within an age-sex cohort as identical. In this draft we will indicate possible types of aggregation bias; a subsequent version of this paper will investigate the sensitivity of our findings to this issue. The second source of potential error relates to the reliability of the data. The data used come from a wide variety of sources including the National Income Accounts, the Survey of Consumer Expenditures, the Social Security Administration, and the Internal Revenue Service. Wherever possible, we will indicate the sensitivity of our results to possible inaccuracies in the underlying data. The third source of potential error arises from assuming that the cross-sectional age-earnings and age-consumption profiles for years prior to 1940 were of a similar shape to those after 1940. Data is not available to estimate these curves for the pre-1940 period. Again we will consider how our findings would be altered by reasonable deviations from this assumption.

The paper proceeds with a brief review of the pertinent literature. In section II we indicate our basic methodology. Section III is devoted to a discussion of the data and its implementation in our calculation. In section IV we present our preliminary findings, and we conclude in Section V.

I. A Brief Review of Pertinent Studies

We are currently aware of four studies that pose the question, how much of accumulation is due to life cycle behavior. These studies provide widely different answers. James Tobin (1967) presents a simulation analysis of a hypothetical life cycle economy, calculates the accumulation implied by the model, and concludes: "it seems quite possible that life cycle saving can account for the United States capital stock."[3] Betsy White (1978) comes to a quite different answer using a similar simulation model:[4]

> The major conclusion drawn from this analysis is that saving for future consumption does not account for the totality of observed aggregate personal saving. For a wide range of parametric values, the simulated values of aggregate saving fall significantly short of the observed levels. At best the simulated values are about 60 percent of the observed values.

While it is not our purpose here to give a detailed critique of these studies, both the Tobin and White papers completely ignore the existence of the unfunded social security system during this period. Kotlikoff has demonstrated that in a pure life cycle model, unfunded social security at a 10% tax rate would reduce steady state private wealth by about 20%.[5] If Tobin and White had considered the unfunded social security system, both of their life cycle models would have predicted substantially less accumulation and savings then they reported.

Michael Boskin, after an analysis of aggregate estate tax data, concludes that "...a very large fraction (about 80%) of the nonhuman capital stock is due to lifetime accumulation rather than inheritance."[6] Boskin contrasts the size of the yearly flow of taxable bequests with the size of total wealth holdings and finds that total annual transfers thus reported amount to only one-half of one percent of the capital stock. Boskin does not, however, estimate bequests arising from non-taxable estates. In addition, there is very little information available concerning the size as well as timing of intergenerational transfers in the form of gifts. As will be indicated below, the timing of intergenerational transfers plays a major role in the wealth accumulation process.

Michael Darby lines up with Betsy White on the side of small life cycle and large transfer accumulation.[7] Darby's study is conceptually similar to our own. While we consider the origins of asset accumulation, Darby analyzes the destination of current wealth holdings; he divides current asset holdings into a part that will be used to finance future streams of consumption less earned income and a part that will be used to finance future intergenerational transfers. Darby indicates that although

> ...the method of estimation used in this analysis tended to overestimate the portion held for life-cycle purposes,... these life cycle assets were still only 13 to 29 percent of total assets depending on the interest rate used.[8]

Darby's study relies exclusively on data from the 1967 Survey of Economic Opportunity. He uses estimates of savings and income to obtain estimates of the cross sectional profile of average consumption by age for the past 65 generations. Assuming that future cohorts replicate (except for a growth factor) the current age consumption profile of the elderly, Darby calculates the amount of assets needed by current younger generations simply to finance their old age consumption. These assets needed for old age consumption are then contrasted with total assets currently held by the pre-retirement cohorts. While we find Darby's methodology instructive, we do not consider his findings conclusive evidence. Since the SEO over sampled poor households, there is a question as to the representativeness of the wealth by age distribution used by Darby to calculate both consumption and the proportion of total assets which are life cycle. In addition, the analysis relies heavily on information contained in the older tail of the age wealth distribution where sample sizes are presumably quite small.

II. The Division of Assets Into Life Cycle And Transfer Components - Methodological Approach

Our division of assets into the two components is easily understood by considering a simple two period growth model in which individuals work during the first period earning an amount e_y, and are retired in the second period. Letting W stand for total wealth in the economy, P_o for the number of old persons, C_y for consumption when young, and T_y for intergenerational transfers received when young, we have:

$$W = (T_y + e_y - C_y)\, P_o \tag{1}$$

Taking T_o to be the transfers made when old and C_o to be old age consumption, the individual's lifetime budget constraint is:

$$C_y + \frac{C_o}{1+r} + \frac{T_o}{1+r} = e_y + T_y \tag{2}$$

where r is the interest rate.

This paper attempts to estimate the life cycle fraction, $\frac{(e_y - c_y)\, P_o}{W}$, of W in equation (1). Using (2), (1) may be rewritten as:

$$W = \left(\frac{C_o}{1+r} + \frac{T_o}{1+r}\right) P_o \tag{3}$$

Darby's procedure involved estimating the fraction $\frac{(C_o/1+r)\, P_o}{W}$ in (3), i.e., the fraction of current assets needed to finance future consumption. Assuming a steady state in which bequests per head are constant and population grows at rate n, $T_o = T_y(1+n)$. Comparing our procedure with Darby's, it is clear that the two will yield identical steady state fractions in the case $n = r$. When r equals n, the present value of lifetime consumption equals the present value of lifetime earnings. If r exceeds n, part of lifetime consumption is financed by interest earned on received transfers, and Darby's method will yield a larger life cycle fraction than will ours. The opposite holds true when n is less than r.

This discussion suggests that the division of assets into life cycle and transfer assets is, in some sense, artificial. Assets are assets, and the total of assets is determined jointly by the time paths of received lifetime transfers, lifetime earnings, and lifetime consumption. A finding, for example, that 50% of assets are "life cycle" using our definition of the "life cycle" fraction should not be taken to mean that in the absence of transfers assets would be 50% smaller. Since transfers, consumption, and earnings are jointly chosen, a reduction in transfers, T_y, would, presumably, be associated with different levels of C_o, C_y, and e. While our analysis will not indicate the importance of transfers to capital accumulation in the sense of illuminating the lifetime choice between C_y, C_o, and T_o, our analysis will determine whether transfers are a large enough factor to merit investigation of this joint decision.

In the case of a multiperiod framework, total wealth, W, is the sum over a of W(a), the total wealth held by the age a cohort. For the U.S. economy W(a) may be divided into three components, accumulated private transfers, accumulated government transfers, and accumulated "life cycle" savings out of earnings.

$$W(a) \equiv [\int_{18}^{a} \bar{T}_p(a,z)\, e^{r(a-z)}\, dz + \int_{18}^{a} \bar{T}_g(a,z)\, e^{r(a-z)}\, dz + \int_{18}^{a} (\bar{E}(a,z) - \bar{C}(a,z))\, e^{r(a-z)}\, dz]\, P(a) \tag{4}$$

Equation (4) is the fundamental accounting relationship analyzed in this paper. P(a) stands for the current age a population alive in our reference year, which is 1974. $\bar{E}(a,z)$ and $\bar{C}(a,z)$ are, respectively, the average after tax earnings and average consumption of members of the 1974 age a cohort when they were age z. $\bar{T}_p(a,z)$ and $\bar{T}_g(a,z)$ are, respectively, average private and government transfers received by the 1974 age a cohort at age y. $\bar{T}_p(a,z)$ is the net private transfer and may be positive or negative. We take age 18 to be the age of adulthood. Consumption expenditures by adults on children under the age of 18 are considered to be a part of adult consumption rather than intergenerational transfers. r is the after tax nominal interest rate.

Integrating over age cohorts, the fraction we are seeking to estimate is:

$$\frac{\int_{18}^{100} \left(\int_{18}^{a} (\bar{T}_g(a,z) + \bar{E}(a,z) - \bar{C}(a,z))\, e^{r(a,z)} dz\right) P(a)da}{W} \tag{5}$$

$\bar{T}_g(a,z)$ consists primarily of social security benefits, veterans' benefits, and welfare and disability payments. Assets of children under age 18 are assumed to be completely inherited and thus are not included in our "life cycle" fraction (5). In our actual computations the terms $\bar{T}_y(a,z)$, $\bar{E}(a,z)$, and $\bar{C}(a,z)$, are calculated separately for males and females. In section III we indicate the data and procedures used to estimate the terms in (5).

Potential Aggregation Error

Our procedure of treating all individuals of a given age as identical will introduce bias to the extent that individuals with greater life cycle accumulation than the average have greater than average life expectancy. To see this suppose there were two types of individuals, the lifetime rich and the lifetime poor. At age z in year t, let savings out of earnings for the rich be $S_r(z)$ and for the poor $S_p(z)$. In 1974 assume these individuals who were age z in year t are age a. The total accumulated life cycle wealth we should calculate for the age a cohort corresponding to their age z life cycle savings out of earnings is:

$$\text{(A1)} \qquad S_R(z)\ e^{r(a-z)}\ N_R + S_P(z)\ e^{r(a-z)} NP,$$

where N_R and N_P are respectively the number of rich and poor age a in 1974, who were age z in year t and survived to 1974. Instead of (A1), our aggregation procedure leads us to calculate:

$$\text{(A2)} \qquad S_R(z)\ e^{r(a-z)}\ \lambda_R(N_R+N_P) + S_P(z)\ e^{r(a-z)}\ (1-\lambda_R)\ (N_R+N_P),$$

where λ_R is the proportion of lifetime rich in the age z population in year t. Comparing (A2) and (A1), if $\frac{S_R}{S_R+S_P} > \lambda_R$, i.e., the rich have higher survival probabilities, (A1) will exceed (A2) if $S_R(z) > S_P(z)$. This source of bias will, to some extent, cancel over the life cycle. $S_R(z) > S_P(z)$ will presumably hold for young ages, (low z's); during the later years of the life cycle $S_R(z)$ and $S_P(z)$ will be negative, and, hence, $S_R(z) < S_P(z)$ will hold.

Another type of aggregation bias arises from assuming that all individuals experience the same rate of return. Suppose two individuals have the same savings out of earnings K(z) at age z, but one faces a net return of 10% and the other 0%. For these individuals who reach age a in 1974 we should calculate $K(z)\ (e^{.1(a-z)} + 1)$. INSTEAD we calculate $K(z)(e^{.05(a-z)} + e^{.05(a-z)})$, where .05 is the average rate of return. If (a-z) is large, the error in our procedure will be substantial. Again, the potential error is mitigated to some extent, because K(z) will be negative for some years and positive for other years. In this draft we investigate the sensitivity of our findings to this second type of aggregation bias.

III. The Data and Estimation Procedure

The number of persons at each age in every year from 1900 through 1974 is one of the key pieces of information used in our analysis. The U.S. Bureau of the Census has published estimates of the population for each year by age and sex.[9] To calculate $\bar{E}(a,z)$ we make use of the population data as well as information on aggregate after-tax labor income, age earnings profiles, labor force participation rate profiles by age, and work experience profiles by age. To illustrate the computation we must define the following terms:

$\bar{e}_t$ - average earnings of 40 year old male workers in year t

$g_m(a,t)$ - ratio of average earnings of male workers at age a in year t to average earnings of 40 year old male workers in year t.

$g_f(a,t)$ - ratio of average earnings of female workers at age a in year t to average earnings of 40 year old female workers in year t.

λ_t - ratio of average earnings of 40 year old male workers to average earnings of 40 year old female workers.

$\alpha_m(a,t)$ - percentage of males age a with work experience in year t.

$\alpha_f(a,t)$ - percentage of females age a with work experience in year t

H_t - total after-tax labor income in year t.

$P_m(a,t)$ - population of males age a in year t

$P_f(a,t)$ - population of females age a in year t

Assuming we have information on all of the above variables except $\bar{e}_t$, we can use equation (6) to solve for $\bar{e}_t$:

$$H_t = \bar{e}_t \int_{18}^{100} (g_m(a,t)\ \alpha_m(a,t)\ P_m(a,t) + \lambda_t\ g_f(a,t)\ \alpha_f(a,t)\ P_f(a,t))da \tag{6}$$

Given $\bar{e}_t$, $\bar{E}_m(a,z)$ for males and $\bar{E}_f(a,z)$ for females satisfy:

$$\bar{E}_m(a,z) = \bar{E}_m(a,a-(1974-t)) = \bar{e}_t\ g_m(a,t)\ \alpha_m(a,t) \tag{7}$$

$$\bar{E}_f(a,z) = \bar{E}_f(a,a-(1974-t)) = \bar{e}_t\ \lambda_t\ g_t(a,t)\ \alpha_f(a,t) \tag{8}$$

Information on aggregate labor earnings after 1929 is obtained from the National Income Accounts. Prior to 1929 we use estimates from Kuznets and Levin et. al. For years prior to 1909 labor compensation is imputed from Kendrix's estimates of net national product using the ratios of labor compensation to national product for the years 1909 to 1918.[10] In this initial investigation we include 80% proprietor's income in labor income. Estimates of state and federal income taxes on labor income and non-social security transfers were obtained from IRS Statistics of Income and The National Income and Product Accounts. Total taxes were apportioned to labor and capital income according to their shares in gross income.

Estimates of the age earnings profiles for men and women were obtained by fitting separate polynomials to social security estimates of median annual earnings of workers by age for the years 1937-1977.[11] These regressions included higher order terms in age, time, and interactions between age and time. The general shapes of the profiles predicted by the regressions are quite similar throughout the 1937-1975 period. For the years prior to 1937, the predicted male and female age-earnings profiles for the year 1955 were used. The year 1955 was chosen because by 1937 the social security data covers most of the private economy's work force. While we use these social security profiles in this draft, age earnings profiles have also been estimated from data available in the U.S. Department of Commerce, Current Population Reports and the U.S. Census for census years after 1930. The profiles obtained were very similar in shape to those generated with the social security data. The value of λ_t was taken to be .4 throughout the period. This value was chosen from an examination of median social security estimated earnings by age and sex.

Values for work experience rates by age and sex, $\alpha_m(a,t)$ and $\alpha_f(a,t)$, are only available after 1959.[12] Substantially more information, especially for the early 1900's, is available on labor force participation rates by age and sex. Regression analysis for the post 1959 period indicates that the ratios $\alpha_m(a,t)/L_m(a,t)$ and $\alpha_f(a,t)/L_f(a,t)$, where $L_m(a,t)$ and $L_f(a,t)$ are male and female labor force participation rates, are quite staple functions of age and labor force participation rates plus higher order terms in these variables.

We chose, therefore, to estimate the α functions with estimates of the labor force participation rate times a correction factor equal to the predicted ratio of the work experience rate to the labor force participation rate. This correction factor is obtained from the α/L regressions. The labor force participation rates by age and sex for each year are the values predicted from regressions of labor force participation rates on age and higher order terms in age for related years.[13]

The terms $\bar{C}(a,z)$ are calculated by a procedure similar to the one just described. Letting $\bar{c}_t$ be the average consumption of a 40 year old in year t, and $\gamma(a,t)$, the ratio of average consumption of individuals age a to average consumption of 40 years olds, we have:

$$(9) \qquad F_t = \bar{c}_t \int_{18}^{100} \gamma(a,t)(P_m(a,t) + P_f(a,t))\, da$$

In (9) F_t is total private consumption expenditures. Given values of $\gamma(a,t)$, we solve for $\bar{c}_t$ and obtain:

$$(10) \qquad \bar{C}(a,z) = \bar{C}(a,a-(1974-t)) = \bar{c}_t\, \gamma(a,t)$$

To generate the $\gamma(a,t)$ function we analyzed data reported in the Survey of Consumer Expenditures for the years 1950, 1960, 1971-1972. These surveys were conducted at the household level where a household may represent either a single individual or a family. The average annual expenditure of households is reported classified by the age of the head. The age brackets are fairly broad, but the average age of the head in the age bracket is indicated. The average number of adults over age 18 classified by the age of the head is easily obtained for the 1960 and 1971-72 Surveys. Adjustments were made to the 1950 survey to obtain average number of adults. Dividing average consumption expenditure by average number of adults yields data points of average consumption by average

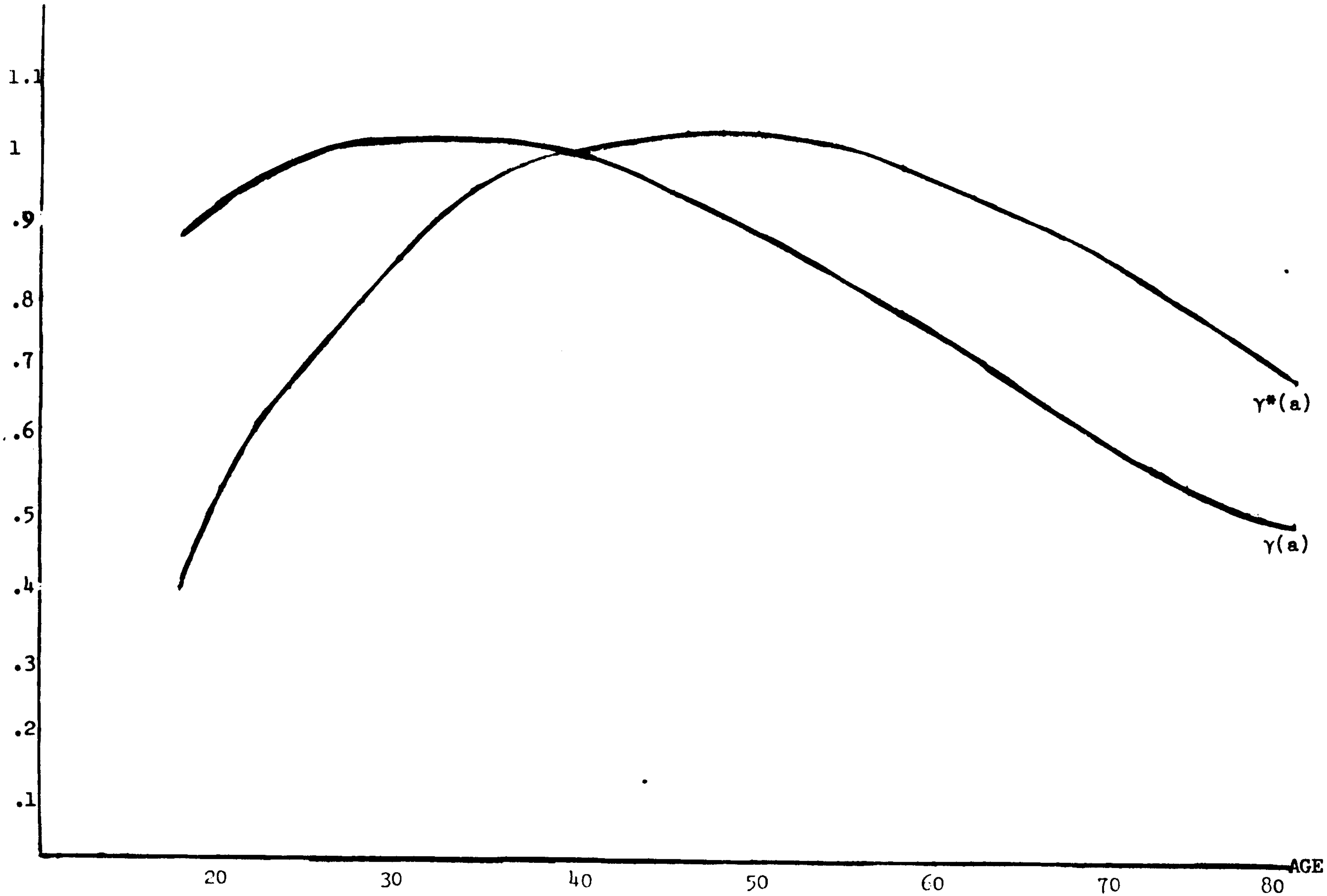
age of the head. Regressions were run for the three survey years relating average consumption to the average age of the head and higher order terms in age. The profiles obtained were essentially identical and all three years of data were pooled to obtain a $\gamma(a)$ function which we assume to hold throughout all time periods.

There are a number of reasons why the derived $\gamma(a)$ function is not ideal. First the average age of the head is not the same as the average age of all adults in the household. Secondly, the fact that the survey was conducted on a household rather than an individual basis probably tends to make our estimated $\gamma(a)$ function too flat. An additional reason why the estimated $\gamma(a)$ could be too flat is that the surveys include expenditure on durables rather than imputed rent on owned homes and durables in the definition of consumption. Interest payments on mortgages are included, but true consumption is probably understated for older households that have paid off most of their mortgages and overstated for younger households, for whom expenditure on durables is a larger fraction of total expenditure.

In Figure 1 we plot the $\gamma(a)$ function found in the regression. We felt that the above mentioned issues were important enough to merit using the $\gamma^*(a)$ function instead of $\gamma(a)$. $\gamma^*(a)$ is also depicted in Figure 1. The $\gamma^*(a)$ function is related to $\gamma(a)$ by $\gamma^*(a) = \gamma(a-15)$. The $\gamma^*(a)$ function allows for substantially more life cycle accumulation than does $\gamma(a)$.

Total consumption expenditure, F_t, is taken from National Income Accounts after 1929 and from Kendrix prior to 1929.[14] Ideally one should subtract out expenditure of consumer durables and add in imputed rent on consumer durables to obtain true economic consumption. The difficulties of implementing this for the pre-1929 years led us to simply use the consumer expenditure series.

I. AGE CONSUMPTION PROFILES



In any case there appears to be very little difference between the consumer expenditure series and the true economic consumption series.[15]

In (9) we are assuming that the average consumption for males and females at a given age is identical. We have no evidence at this time to assess the validity of this assumption. If males and females had identical survival probabilities, our calculated life cycle assets would be independent of how we distributed consumption between sexes within an age cohort. Attributing more consumption to females lowers our calculated female life cycle assets, but raises our calculated male life cycle assets. Since females live longer than males, the total of "life cycle" assets in 1974 is reduced when more consumption is attributed to females.

Because of low female labor work participation rates and low levels of earnings, average earnings of females are significantly lower than average earnings of males of the same age. Assuming that females consume the same average amount as males at a given age implies that females will have negative calculated "life cycle" assets and males positive calculated "life cycle" assets. If we are correct in assuming equal male-female consumption, the consumption of females in excess of their earnings must be financed by transfers, either intergenerational transfers from other relatives, or intragenerational transfers from, for example, husbands. The fraction of wealth accumulation which we calculate and label as "life cycle" is net of all interpersonal transfers, whether they be within or across generations. We recognize that many economists would include within their definition of life cycle accumulation intragenerational transfers from, for example, husbands to wives, that give rise to accumulation because of differential male-female mortality. Rather than argue over definitions, we shall indicate below how inclusion of accumulation arising from intragenerational transfers would affect our calculated life cycle fraction.

At this point it seems appropriate to remark that even adding accumulated intragenerational transfers to our calculated "life cycle" assets would leave some economists dissatisfied. They would argue that some intergenerational transfers are essentially life cycle and should be included. For example, if a husband is two years older than his wife and he dies at age 50, they would consider the assets he passes to her as essentially "life cycle", where by "life cycle" they would mean the combined life cycles of the husband and wife. These economists would distinguish between transfers that are made to people not much younger and transfers that are made to people very much younger. In the next draft of this paper we will use estate tax data and attempt to divide our residual transfer fraction of wealth into transfers made to people close in age and transfers made to people far away in age.

Returning to (5), the $\bar{T}_g(a,z)$ values may be obtained by examining social security benefit data for the period 1937-1974 as well as data on other government transfer payments. Social security taxes must also be subtracted out of H_t. While estimates for social security benefits and taxes will soon be calculated, time did not permit their inclusion in this version of the paper. We choose here only to include other non-social security government transfer payments. This decision will bias our estimates of the "life cycle" fraction upward, because of the higher mortality of the elderly who receive social security benefits transfers and the lower mortality of the young who pay social security taxes.

We present estimates of (5) for a range of constant values of r. We also calculate a portfolio weighted net nominal rate of return for private wealth using data on historical rates of return[16] and data from Goldsmith on portfolio shares. From Goldsmith's balance sheets we generate six asset categories plus liabilities. These are tangible assets including land and structures, money, short term claims (savings accounts and U.S. treasury bills), corporate stock, long term corporate bonds, and U.S. savings bonds. A rate of return series was associated with each asset type as well as the liabilities. A weighted rate of return was calculated taking the share of each item in net worth during the period considered as the weight.

The rate of return on liabilities was taken to be the prevailing mortgage rate and entered with a negative weight.[17] For tangible assets the rate of return after 1929 was estimated as the percentage increment in the GNP price deflator for fixed investment. Prior to 1929 we use Goldsmith's series on the value of one family houses.[18] Rates of return on stocks from 1926-1974 are reported in Ibbotson and Singuefield (1976). Prior to 1926 we assume a 5% dividend and add in the capital gain on stocks indicated by the Standard and Poor's Index.[19] Long term corporate bonds returns are also available from 1926 from Ibbotson and Singuefield as are returns on U.S. Savings Bonds and Treasury Bills. Prior to 1926 we follow Ibbotson and Singuefield and assume a 4% coupon on long term corporate bonds. The percentage revaluation of corporate bonds is given by the Standard and Poor's Index of Aaa bond prices.[20] Prior to 1926 the U.S. savings bond return was assumed to equal the return on long term corporate bonds. The U.S. treasury bill return was applied to short term claims after 1926. For the earlier period the short-term rate of return was measured as the yield on corporate bonds with one year to maturity less 2%.[21] The portfolio shares are available for the years 1900, 1912, 1922, 1929, 1933, 1939, 1945, 1950, 1955, 1958, and 1968. For years in which no share values are available, we use the shares in the closest year in which the shares are available. Using statistics of income we reduce our weighted nominal rate of return by the average income tax rate prevailing in each year.

IV. Preliminary Findings

The benchmark figure for private household wealth in 1974 is 4.396 trillion dollars. This is the number we compare with accumulated "life cycle" assets. This value for total household wealth is the one used in the FRB-MIT-PENN model. The wealth number includes estimates of the market value of financial assets, liabilities, and tangible assets, including consumer durables, residential structures, and land. The series is based on Goldsmith's seminal work, A Study of Saving in the United States.

Using our weighted net nominal interest rate and the $\gamma^*(a)$ function, assuming proprietor's labor income is .8 times their total income, and assuming equal male and female consumption at the same age, we calculate 228 billion dollars of 1974 accumulated "life cycle" assets. This figure is strikingly small; it represents only 5.2% of the total private net worth in 1974. Given that we have made a number of assumptions which would tend to bias upwards our "life cycle" estimate, and given that we have not yet adjusted for social security taxes and transfers, the finding is even more surprising. While we caution that these results are quite preliminary, a consideration of the separate elements involved in our computations is helpful for understanding why calculated "life cycle" assets are so small.

In Table 1 we present the time series for employee and proprietor labor earnings net of income taxes less non-social security government transfer (1+t). We also present the time series on aggregate consumption expenditure. For all but 5 years from 1900 through 1974 aggregate consumption expenditure exceeds net labor earnings; for many years the differential is quite large. The observation that consumption exceeds earnings, by itself, does not lessen belief in the life cycle model. Indeed, for life cycle steady states in

Table 1 (in billions)

Year	Net Labor Earnings	Consumption Expenditure	Year	Net Labor Earnings	Consumption Expenditure
1900	12.1	13.6	1927	59.5	72.6
1901	13.5	15.2	1928	60.5	74.9
1902	14.0	15.9	1929	63.3	78.9
1903	14.9	17.0	1930	56.9	69.9
1904	14.8	17.5	1931	48.9	60.5
1905	16.3	18.8	1932	36.7	48.6
1906	18.8	21.1	1933	35.3	45.8
1907	19.8	22.5	1934	41.4	51.3
1908	17.9	21.2	1935	47.1	55.7
1909	21.1	24.2	1936	53.6	61.9
1910	22.3	25.5	1937	59.3	66.5
1911	22.4	26.4	1938	55.6	63.9
1912	24.1	28.3	1939	59.1	66.8
1913	25.3	29.4	1940	63.7	70.8
1914	25.1	29.4	1941	77.6	80.6
1915	26.3	29.8	1942	98.7	88.5
1916	30.9	36.5	1943	121.3	99.3
1917	36.9	44.2	1944	132.8	108.2
1918	44.6	50.7	1945	137.8	119.7
1919	51.6	53.3	1946	142.8	143.4
1920	55.4	62.6	1947	151.5	160.7
1921	43.4	58.2	1948	169.5	173.5
1922	46.0	57.3	1949	167.3	176.8
1923	53.8	63.7	1950	181.6	191.0
1924	53.9	67.6	1951	201.8	206.3
1925	56.8	67.2	1952	213.1	216.7
1926	59.6	73.0	1953	223.9	230.0

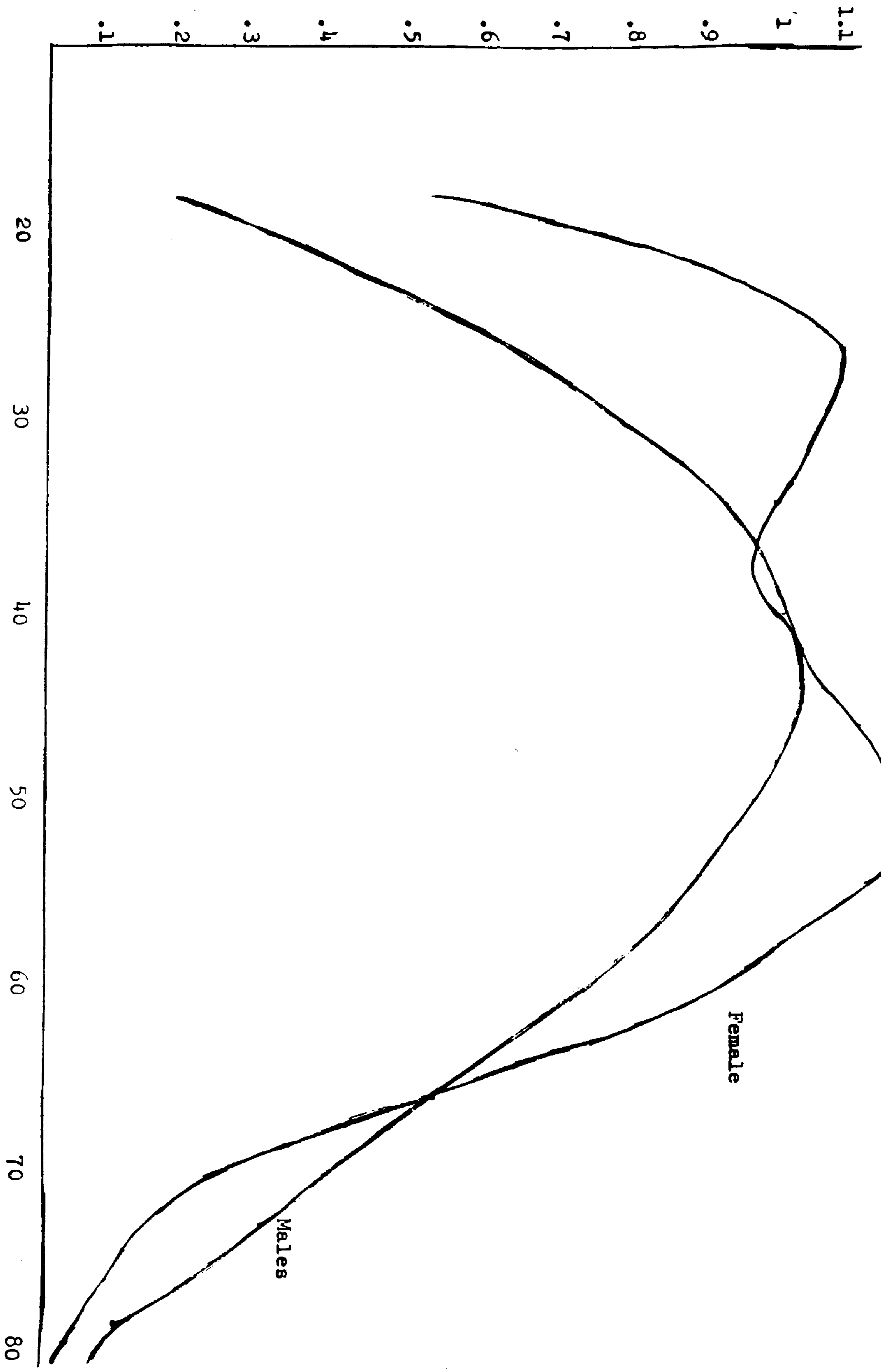
Table I

Year	Net Labor Earnings	Consumption Expenditures
1954	226.5	236.5
1955	241.3	254.3
1956	258.0	266.7
1957	271.4	281.4
1958	278.3	290.1
1959	294.4	311.2
1960	309.2	325.2
1961	318.8	335.1
1962	337.6	355.1
1963	354.2	375.0
1964	381.6	401.2
1965	412.3	432.8
1966	452.0	466.3
1967	481.4	492.1
1968	519.7	536.2
1969	565.6	579.5
1970	610.6	618.8
1971	660.6	668.2
1972	724.4	733.0
1973	810.0	809.6
1974	877.0	889.6

which the interest rate exceeds the population growth rate, consumption will always exceed labor earnings. However, given that aggregate net earnings fall short of consumption, age-earnings and age-consumption profiles must exhibit quite special differential curvatures for the pure life cycle model to explain the large net worth figure of 4.4 trillion dollars. In particular, life cycle accumulation will be greater to the extent that the age-earnings profile peaks at young ages, and the age-consumption profile is very low for young ages and peaks at very old ages.

In Figure 2 we plot predicted relative average earnings for males and females for the year 1951. Predicted profiles for other years for males have quite similar shapes. Over time the female profile begins to look more and more like the male profile. The double peaking of the female profile in the 1950's reflects withdrawal from the labor market of middle age females presumably to raise children and subsequent reentry. The main point to be made here is that a substantial fraction of the aggregate earnings is being earned by older cohorts, rather than younger ones. For males, the average earnings by age profile doesn't peak until the mid-40s. Neither the earnings profiles nor the consumption profiles exhibit curvatures suggestive of substantial "life cycle" accumulation.

In addition to using the weighted net nominal return we calculated "life cycle" accumulation using a constant 2%, 4%, and 6% interest rate throughout the period. These number bracket the mean of the weighted net interest rate series, which is 4.3%. The calculated values are $403 billion at 2%, $274 billion at 4%, and $95 billion at 6%. The greater longevity of females and their negative "life cycle" asset positions appear to make the total of "life cycle" assets decline with the interest rate.



2. Predicted Relative Earnings by Age, Males and Females, 1951

Sensitivity Analysis and Aggregation Bias

We next considered the sensitivity of our calculation to the assumptions that the typical female workers age 40 earn only 40% of what the typical male age 40 worker earns. In addition, we changed our assumption that males and females consume equally at a given age, to assuming that females consume only 40% of what males of the same age consume. These changes raise "life cycle" accumulation to $806 billion using the net interest rate, and $714 billion, $830 billion, and $836 billion using constant 2%, 4%, and 6% rates of return. Using the $806 billion figure raises the life cycle fraction to 18.3%. The difference between the initial 5.2% fraction and this 18.3% fraction arises primarily from changing the assumption about female consumption relative to male consumption.

To test the sensitivity of the calculation to the assumption that all individuals receive an identical rate of return on their assets, we changed the computer program to permit 10% of the males to receive a constant 10% rate of return over their lifetimes. Using the initial set of other assumptions, life cycle accumulation rises to 1.563 trillion dollars, or 35.5% of private net wealth. Clearly, very high rates of return for some life cyclers relative to others may play an important role in the accumulation process. However, even this seemingly unrealistic assumption, that 10% of all males receive a constant 10% rate of return, fails to explain much more than a third of total private net worth.

Some Initial Thoughts About Explaining the Residual

The residual fraction of unexplained net worth arises from both intergenerational and intragenerational transfers. To gain some idea about the size of the intragenerational transfer component, we calculated accumulated assets assuming that males at a given age transfer roughly 50% of their earnings to females of the same age. This assumption leads to an additional $800 billion of accumulation. At this early stage, then, intragenerational transfers seem capable of explaining perhaps 10% of total accumulation. Allowing for these intragenerational transfers reduces, however, the net worth of males. Hence, combining the assumptions that males transfer 50% of their earnings to females with the assumption that 10% of the males enjoy a constant 10% rate of return still only brings us to an accumulation total of $1.449 trillion dollars, or 33.0% of private net worth.

At this stage it appears that even allowing for differentially high rates of return for some individuals and allowing for intragenerational transfers still leaves a residual 70% of total accumulation to be explained by intergenerational transfers or other aggregation biases. While we are still investigating data sources, there appears to be little information as to the size of total annual flows of intergenerational transfers as well as the ages at which these transfers are received. Data on the flow of bequests transfers from taxable estates is reported by the IRS. In 1973 about $25 billion dollars was transfered by these wealthy decedents who represented about 8.6% of all deaths. Given the extreme concentration of wealth holdings, non-taxable estates probably transfered no more than $25 billion dollars to their decedents. We take total transfers at death in 1973 to be roughly $50 billion. This $50 billion represented about 6.25% of gross wages and salary earnings in 1975. If we assume that this ratio stayed roughly constant from 1900 to 1974, we can use the series on wage and salary earnings to generate a series on annual bequest transfers. The gross wage and salary series was chosen at this stage simply for analytical convenience. If we also assume that the age distribution function of received bequest transfers takes the same shape as our $\gamma^*(a)$ function, we can generate an, admittedly very rough, estimate of accumulated bequest transfers. This figure is $966.8 billion dollars using our weighted interest rate. Assuming a constant 4% interest rate leads to $975.4 billion; with a constant 6% interest rate the figure is $1.356 trillion. $966.8 billion is only 22.0% of net worth in 1974. This figure is probably biased upwards because the true age distribution function for received bequest transfers is probably much more skewed to older ages than is indicated by $\gamma^*(a)$. In addition, bequest transfers at death are in part intragenerational as well as intergenerational. Since we have already investigated intragenerational transfers, adding in the total of $966.8 billion of accumulated bequest transfers to the $1.449 trillion of accumulated "life cycle" and intragenerational transfers involves some double counting. Still, it is surprising that the two components together only explain 55% of private net worth in 1974, and we still have not adjusted for social security transfers.

V. Conclusion - An Unresolved Puzzle

There appears to be two possible explanations of the remaining unexplained 45% to perhaps 60% of accumulated wealth. The first explanation is that unreported inter-vivos transfers are very, very large. There are an ample supply of stories indicating how the super rich transfer their wealth without paying gift or estate taxes; little, however, is known about the magnitude of these types of transfers. The second explanation is that a sizeable amount of life cycle assets are under-estimated because of aggregation bias. The lifetime rich may experience much greater logevity than the lifetime poor. Our treating all individuals within an age as identical will, then, lead to a downwar biased "life cycle" accumulation figure. In the next draft of this paper we will investigate this possible source of bias as well as the issue of social security transfers. At this point we doubt that allowing the lifetime rich reasonably larger lifespans than the lifetime poor can have a major impact on the findings.

To conclude, we feel that our findings constitute fairly strong evidence that the purest version of the life cycle theory falls very short of explaining aggregate wealth accumulation. Adding in intragenerational transfers as well as "close in age" intergenerational transfers from husbands to wives appears to still leave a large unexplained wealth residual. This large residual fraction may correspond to substantial "far in age" intergenerational transfers, but more transfer data may have to be collected before this issue is resolved. A view of U.S. wealth accumulation as reflecting primarily average life cycle savings of the average American can not be supported by the data.

FOOTNOTES

[1] See Martin Feldstein, "Social Security, Induced Retirement, and Aggregate Capital Accumulation," Robert Barro, "Are Government Bonds Net Wealth?" and Guillermo Calvo, et. al., "The Incidence of a Tax on Pure Rent: A New (?) Reason for an Old Answer."

[2] See Betsy B. White, "Empirical Tests of the Life Cycle Hypothesis," and James Tobin, "Life Cycle Saving and Balanced Growth."

[3] James Tobin, op. cit., p. 256.

[4] Betsy B. White, op. cit., p. 547.

[5] Laurence J. Kotlikoff, "Social Security and Equilibrium Capital Intensity".

[6] Michael J. Boskin, "Is Heavy Taxation of Capital Socially Desirable?", p. 252.

[7] Michael R. Darby, "The Effects of Social Security on Income and the Capital Stock".

[8] Darby, op. cit., p. 3.

[9] Prior to 1940 all individuals age 75 and over were jointly enumerated. After 1940 all individuals 85 and over are jointly enumerated. In our analysis of fraction (5) we integrate over age only up to age 85 and take P(85) to include all individuals 85 and over.

[10] See Kuznets, National Product Since 1869 and National Income and Its Composition, 1919-1938, Levin, et. al., America's Capacity to Consume, and Kendrix's Series A6 and B61 in Long Term Economic Growth.

[11] U.S. Social Security Administration, Annual Statistical Supplement, 1975.

[12] See, Employment and Training Report of the President, 1978.

[13] Data for the labor force participation rate regressions comes from the U.S. Census starting in 1890 and from the Employment and Training Report of the President, 1978. A labor force participation regression was estimated for males using pooled Census data for 1900, 1910, and 1920. This function was used to impute male labor force participation rates up to 1925. For females the early period participation function was obtained from a regression using 1900, 1910, 1920, and 1930 Census data. This function was used to impute female participation rates up to 1935. In addition, separate regressions were run for males using Census data for each of the years 1930, 1940, 1950, 1960, and 1970. For females regressions were run using Census data for 1940, 1950, 1960, and 1970. For both males and females the participation rates used for non-census years were taken from the closest year adacent regression. We are still experimenting with how best to use supplementary data in the Employment and Training Report of the President.

[14] See Long Term Economic Growth, consumption expenditure.

[15] To see this compare Christensen and Jorgenson's "true" consumption series in U.S. Income, Savings and Wealth with the National Income Account Series for 1929-1969.

[16] See Goldsmith, Studies in the National Balance Sheet of the United States, vol. II. Goldsmith's data extends to 1958. Smith (1974) presented an updated Goldsmith-type balance sheet for 1968, which we employ.

[17] Manhattan Island Real Estate Mortgage Rates: Roy Wenzlick Research Corp., reported in Long Term Economic Growth, series B77.

[18] National Income and Product Accounts and Goldsmith, Studies in the National Balance Sheet, vol. I, pp. 170-71.

[19] Historical Statistics, p. 1004.

[20] Ibid.

[21] Ibid., p. 1004.

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