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THE ROLE OF INTERGENERATIONAL TRANSFERS IN AGGREGATE CAPITAL ACCUMULATION

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ABSTRACT

This paper uses historical U.S. data to directly estimate the contribution of intergenerational transfers to aggregate capital accumulation. The evidence presented indicates that intergenerational transfers account for the vast majority of aggregate U.S. capital formation; only a negligible fraction of actual capital accumulation can be traced to life cycle or "hump" savings. A major difference between this study and previous investigations of this issue is the use of actual rather than hypothetical longitudinal age consumption profiles. These profiles are simply too flat to generate substantial life cycle savings.

This paper suggests the importance of and need for substantially greater research and data collection on intergenerational transfers. Life cycle models of savings which emphasize savings for retirement as the dominate form of capital accumulation should give way to models which emphasize the rather massive intergenerational transfers in the U.S. economy.

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A quarter of a century has passed since Franco Modigliani and Richard Brumberg presented their Life Cycle Theory of Saving.[1] 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 capital accumulation remains unresolved.[2] This paper presents evidence that the pure life cycle component of aggregate U.S. savings is very small. Intergenerational transfers appear to be the major element determining capital accumulation in the United States.

Distinguishing the roles of life cycle saving and intergenerational transfers in the capital accumulation process seems to be a sine qua non for informed discussion of a number of important economic issues. The traditional Life Cycle Model which either assumes away or denigrates the importance of intergenerational transfers has been the principal paradigm of savings behavior used in economic analysis for the past twenty years. The Life Cycle Model provides a theory of the distribution of wealth as well as theories of the incidence and optimality of taxation.[3] It has been used as the basis for studies of the effects of taxation, social security, demographic change, and stabilization policies on capital formation.[4] Economic models which incorporate intergenerational transfers can generate strikingly different results for a number of major economic issues, including the burden of the national debt, the impact of social security on savings, the incidence of taxation, the perpetuation of the inequality of wealth, and the optimal structuring of taxes to promote economic growth.[5]

This paper uses historical U.S. data to directly estimate the importance of intergenerational transfers as opposed to life cycle savings to the U.S. capital stock. Our finding that intergenerational transfers explain the great bulk of U.S. wealth holding is based on a new methodological approach to the problem.[6] In particular, we make use of a variety of historical U.S. data detailing population, labor earnings, consumption, and government taxes and transfers to directly estimate the shapes of historic age earnings and age consumption profiles. These profiles are then used in conjunction with data on rates of return to calculate a stock of life cycle wealth. This stock of life cycle wealth is compared with aggregate wealth holdings in the United States. If there were no intergenerational transfers, the stock of life cycle wealth would exactly equal total U.S. wealth. When intergenerational transfers occur, these two stocks differ by an amount equal to the stock of net received transfers. Hence, comparing total wealth with life cycle wealth indicates whether the life cycle model, by itself, can explain aggregate U.S. capital formation. We find that lifetime consumption and earnings profiles do not exhibit the kind of shapes needed to generate substantial life cycle savings. Log linear approximations to these profiles suggest that growth rates of real earnings slightly exceed growth rates of real consumption over the lifetime. Since the life cycle theory strongly relies on a lifetime growth rate of consumption in excess of the growth rate of earnings, the life cycle theory of savings with no intergenerational transfers is a very poor description of the process of capital accumulation in the U.S. economy.

Our findings are in agreement with recent studies by Betsy White (1978) and Michael Darby (1979) which use different data and techniques to address this issue. White uses a life cycle simulation model and concludes,

> For a wide range of parametric values, the simulated (life cycle) values of aggregate savings fall significantly short of the observed levels. At best the simulated values are about 60 percent of the observed values.[7]

Darby's study is conceptually similar to our own. Darby analyzes micro data and 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]

Our results rationalize other stylized facts about the U.S. economy which are at odds with the life cycle theory. Mirer (1979) presents evidence from social security data that, "...the aged do not run down their wealth during their lifetime."[9] Indeed, after he adjusts for inter-cohort differences in wealth at retirement, Mirer finds, "...that wealth clearly increases with age."[10] Darby (1979) points out that although the ratio of expected retirement years to expected life span increased by 67 percent from 1890 to 1930, aggregate savings rates showed no increase during this period as would be predicted by the life cycle theory.[11] Atkinson (1971) and Oulton (1976) construct life cycle models to determine how much of observed British inequality of wealth may be explained by this theory. The answer is very little. After taking into account inequality in age earnings profiles and realized rates of return, Oulton concludes, "The results indicate that none of these factors, either singly or in combination, are capable of accounting for a substantial proportion of actual wealth inequality."[12]

We have two objectives in writing this paper. One is simply to answer an accounting question, viz.; Can Life Cycle Savings by itself account for the U.S. capital stock? The second goal is to answer the economic question, how important are intergenerational transfers to U.S. capital accumulation? These questions do not ask the same thing; decisions about lifetime consumption and lifetime intergenerational transfers are jointly made, hence answering the latter question requires explicit recognition of this interdependence.

Section I presents a theoretical framework for considering the importance of intergenerational transfers to aggregate capital accumulation. We indicate here the difference between the accounting and the economic questions posed above. In Section II we discuss our procedure to estimate the stock of life cycle wealth. The data used in this calculation are described in Section III. Section IV presents and intuitively motivates our finding. The sensitivity of our findings to reasonable possible errors in the data and estimation procedure is also considered. The fifth section is devoted to explaining the residual between total U.S. wealth and the stock of life cycle wealth. This residual equals the stock of accumulated net received transfers. Using the limited information available, we attempt to show that the annual flow of transfers and the age difference between donors and recipients is consistent with our estimate of transfer wealth. The sixth and final section of the paper presents the conclusions and discusses some of their implications.

I. Life Cycle and Transfer Wealth -- A Theoretical Framework

The division of the stock of wealth, W, into life cycle and transfer components, respectively L and T, is easily understood by considering a three period model of economic growth with identical individuals in each age cohort. At a point in time aggregate wealth in the economy is the sum of individual wealth holdings. Letting W_i stand for the wealth holdings of a representative individual of age i and P_i for the population of individuals aged i, we can write:

$$(1) \qquad W = W_1P_1 + W_2P_2 + W_3P_3$$

The W_i's equal, by definition, accumulated flows of net received transfers, accumulated flows of earnings net of government taxes less government transfers, and accumlated flows of consumption, where accumulation takes place at the interest rate r. Let T^k_{ij} be the net transfer received at age i from individuals age j for individuals who are currently age k. For example, T^3_{12}, represents the net transfer (which may be positive or negative) that a current 3-period old individual received at the time he (she) was one period old from individuals who were then two periods old. Let e^k_i and c^k_i represent the earnings and consumption of k period old individuals when they were i periods old. Assuming that earnings and consumption occur at the end of each period, W_1, the wealth of age 1 individuals, equals zero. Using the notation for T^k_{ij}, e^k_i, and c^k_i, we can express W_2 and W_3 as:

$$(2) \qquad W_2 = (T^2_{12}+T^2_{13})\ (1+r) + (e^2_1-c^2_1)(1+r)$$

$$W_3 = (T^3_{12}+T^3_{13})\ (1+r)^2 + (T^3_{21}+T^3_{23})(1+r)$$

$$+ (e^3_1-c^3_1)(1+r)^2 + (e^3_2-c^3_2)(1+r)$$

Combining (1) and (2), yields :

$$(3) \qquad W = T + L$$

where
$$T = (T^2_{12}+T^2_{13})(1+r)\ P_2 + [(T^3_{12}+T^3_{13})(1+r)^2 + (T^3_{21}+T^3_{23})(1+r)]P_3$$

$$L = (e^2_1-c^2_1)(1+r)\ P_2 + [(e^3_1-c^3_1)(1+r)^2 + (1+r)\ (e^3_2-c^3_2)]P_3$$

Equation (3) is the fundamental accounting relationship analyzed in this paper. Transfer wealth, T, corresponds to accumulated net received transfers, while life cycle wealth, L, corresponds to accumulated earnings less accumulated consumption. Clearly, in a world with no intergenerational transfers, T would equal zero, and W would equal L. Our first goal is to establish the relative magnitudes of the two components T and L and, thereby, determine whether U.S. wealth holdings can be predominantly explained by life cycle savings. Since substantially less information is available about the values of the T^k_{ij}, most of our efforts in this paper are devoted to calculating the value of L. In section V, however, we do attempt to estimate T directly using fragmentary data and invoking steady state assumptions.

If the economy is in a steady state, net intergenerational transfers received at a given age are constant through time, so that:

$$\begin{aligned} T_{12} &= T_{12}^2 = T_{12}^3 \\ T_{13} &= T_{13}^2 = T_{13}^3 \\ T_{21} &= T_{21}^3 \\ T_{23} &= T_{23}^3 \end{aligned} \tag{4}$$

Assuming that population grows at a constant rate n,

$$P_1 = P_3(1+n)^2 \quad \text{and } P_1 = P_2(1+n) \tag{5}$$

Since transfers received by age group i from age group j equal the negative of group j's transfers from age group i,

$$T_{ij}\ P_i = -T_{ji}\ P_j, \text{ and} \tag{6}$$

$$T_{12}\ P_1 = -T_{21}\ P_2 \tag{7}$$

Using (4), (5), (6), and (7), we may express T in the steady state as:[13]

$$T = P_1\left[T_{13}\left(\frac{1+r}{1+n} + \frac{(1+r)^2}{(1+n)^2}\right) + T_{12}\ \frac{(1+r)^2}{(1+n)^2} + T_{23}\ \frac{(1+r)}{(1+n)^2}\right] \tag{8}$$

If we further assume that r=n, T equals the yearly net flow of transfers from old to young cohorts, t, multiplied by the transfer weighted age gap, g, between donors and recipients:[14]

$$T = (P_1(T_{12}+T_{13}) + P_2\ T_{23}) \cdot \left[\frac{T_{12}P_1+2T_{13}P_1+T_{23}P_2}{P_1(T_{12}+T_{13})+P_2T_{23}}\right] \equiv t \cdot g \tag{9}$$

If r exceeds (is less than) n, accumulated transfer wealth will exceed (be less than) the annual flow of transfers times the weighted average age gap. Equations (8) and (9) show that the contribution of transfers for the total stock of wealth depends critically on both the volume of the annual flow of transfers and the age span of transfers. Equation (8) is used in section V which attempts to directly estimate the size of T.

The second goal of this paper is to ask the economic question how would the U.S. capital stock, W, change if, because of changes in taxes or tases, intergenerational transfer wealth, T, was reduced. That is, we recognize the possibility that changes in transfers might induce changes in consumption and earnings paths and thus alter the life cycle component of wealth. This question may be posed in both partial and general equilibrium contexts. The partial equilibrium change in W resulting from a reduction in T holds wage rates and interest rates constant and corresponds to a shift in the household supply curve of capital.

For purposes of this paper we consider only the steady state partial equilibrium impact of changes in transfers on the capital stock. An empirical calculation of the general equilibrium effect requires knowledge of the responsiveness of the shapes of earnings, consumption, and lifetime transfer profiles to changes in interest rates and wages.[15] This information is currently unavailable.[16]

The Steady State Partial Equilibrium Reduction in Capital Intensity Arising From a Reduction in Intergenerational Transfers

In order to analyze the partial equilibrium reduction in the stock of wealth we first note that life cycle wealth, L, equals accumulated earnings minus accumulated consumption. Accumulated earnings, in turn, equals accumulated wages at full time work minus the accumulated value of leisure. Letting C stand for accumulated consumption, S for accumulated full time wages, and M for the accumulated value of leisure, we rewrite (3) as:

$$W = T + S - M - C \tag{3'}$$

The partial equilibrium percentage reduction in W for a percentage change in transfer wealth, T, equals:[17]

$$\frac{\partial W}{\partial T}\frac{T}{W} = \left(1 - \frac{\partial M}{\partial T} - \frac{\partial C}{\partial T}\right)\frac{T}{W} \tag{10}$$

Equation (10) indicates that the proportionate reduction in the capital stock equals the share of transfer wealth in aggregate wealth, T/W, minus two additional terms indicating how accumulated earnings and accumulated consumption respond to changes in transfers.

Our analysis of the response terms $\frac{\partial M}{\partial T}$ and $\frac{\partial C}{\partial T}$ assume that the utility of consumption and leisure is separable from the utility derived from intergenerational transfers. This assumption implies that the marginal rates of substitution between consumption and leisure at different points in time is independent of the level of intergenerational transfers. Two examples of utility functions exhibiting this property are:

$$U_o = \log C_o + \log C_1 + \log C_2 + \log \ell_1 + \log \ell_2 + \log \ell_3 + \alpha\log T_{12} + \alpha\log T_{13} + \alpha\log T_{21} + \alpha\log T_{23} + \alpha\log T_{31} + \alpha\log T_{32} \tag{11}$$

and

$$U_o = \log C_o + \log C_1 + \log C_2 + \log \ell_1 + \log \ell_2 + \log \ell_3 + \alpha U_1 \tag{11'}$$

The term U_o stands for the utility of a representative individual of generation zero. The terms ℓ_1, ℓ_2 and ℓ_3 corresponds to leisure in different periods. In (11) the individual derives utility directly from the level of net transfers. In (11') the individual derives utility from the utility, U_1, of his decedants. This is an example of an "overlapping utility function." For both types of separable utility functions the marginal rates of substitution between consumption and leisure are independent of the level of α, the preference parameter influencing the size of transfers. In addition, the first order conditions for the optimal choice of consumption and leisure involve the equality between these marginal rates of substitution and the relative prices of consumption and leisure at different ages. Hence, neither changes in transfer preferences nor taxes on intergenerational transfers which affect only the price of transfers, but not the price of consumption or leisure, will alter the first order conditions.

Given the levels of transfers, the utility maximizing levels of consumption and leisure can be separately derived from these first order conditions and the lifetime budget constraint given below:

$$(12)\qquad C_1 + \frac{C_2}{1+r} + \frac{C_3}{(1+r)^2} + M_1 + \frac{M_2}{(1+r)} + \frac{M_3}{(1+r)^2} = s_1 + \frac{s_2}{1+r} + \frac{s_3}{(1+r)^2}$$

$$+ T_{12} + T_{13} + \frac{T_{21}}{1+r} + \frac{T_{23}}{1+r} + \frac{T_{31}}{(1+r)^2} + \frac{T_{32}}{(1+r)^2}$$

In (11) M_1, M_2, and M_3 are the values of leisure in periods 1, 2, and 3 (by value of leisure we mean the number of units of leisure times the price (wage) per unit). The terms s_1, s_2, and s_3 are full time wages in periods 1, 2, and 3. Equation (12) indicates that lifetime consumption and leisure are financed by full time lifetime earnings plus net lifetime received transfers. The separability assumption implies that changes in preferences or taxes that alter the values of the T_{ij} have only an income effect on the choices of consumption and leisure over the lifetime.

We now demonstrate that this income effect of a change in transfers is identically zero for the case that r equals n.[17b] Using (5) and (6) to rewrite (12) we obtain:

$$(12')\qquad C_1 + \frac{C_2}{1+r} + \frac{C_3}{(1+r)^2} \quad M_1 + \frac{M_2}{1+r} + \frac{M_3}{(1+r)^2} = s_1 + \frac{s_2}{1+r} + \frac{s_3}{(1+r)^2}$$

$$+ \frac{T_{12}(r-n)}{(1+r)} + \frac{T_{23}(r-n)}{(1+r)^2} + \frac{T_{13}((1+r)^2-(1+n)^2)}{(1+r)^2}$$

We can also write the budget constraint (12') in terms of aggregate transfer wealth T:

$$(12'')\qquad C_1 + \frac{C_2}{(1+r)} + \frac{C_3}{(1+r)^2} + M_1 + \frac{M_2}{1+r} + \frac{M_3}{(1+r)^2} = s_1 + \frac{s_2}{1+r} + \frac{s_3}{(1+r)^2}$$

$$+ \frac{(r-n)(1+n)^2T}{(1+r)^3}$$

As is clear from (12') or (12"), when r=n, lifetime consumption and leisure are financed solely out of lifetime full earnings, individuals effectively receive their transfers, put them in the bank or other savings vehicles for a period of time, and then transfer the principle plus interest to the next generation. When the population growth rate equals the interest rate, all of the accrued interest on received transfers, as well as the principle itself, is used to maintain steady state transfers per head at a constant level. In the case that r=n, reducing transfers will have no impact on the steady state budget constraint. This, in turn, means that the terms $\frac{\partial M}{\partial T}$ and $\frac{\partial C}{\partial T}$ in (10) are zero when r equals n; i.e., since lifetime consumption and earnings paths stay the same when r=n, steady state life cycle wealth, L, will be unaltered by changes in steady state transfer wealth, T. Thus, any decline in transfer wealth, T, will reduce total wealth, W, dollar for dollar in partial equilibrium when r=n.

Equation (12") indicates that when r differs from n, steady state changes in the level and pattern of transfers (the T_{ij} terms) affect the steady state budget constraint only insofar as they alter the stock of transfer wealth T. This is a general proposition that can easily be shown to hold independent of the number of periods in the model. When r exceeds n part of lifetime consumption and leisure is financed by lifetime transfers. Again, under the separability assumption, the reduction in transfers has simply an income effect on consumption and leisure, and, assuming both are normal goods, will reduce lifetime consumption and raise lifetime earnings. In (10) both $\frac{\partial M}{\partial T}$ and $\frac{\partial C}{\partial T}$ will be positive when r exceeds n. The reverse will be true when n exceeds r.

The value of these terms depends on the particular preferences determining the levels and shapes of consumption and leisure paths. As one example, we present in table I the value of $(1 - \frac{\partial M}{\partial T} - \frac{\partial C}{\partial T})$ for a particular specification of preferences for consumption and leisure and for different values of r and n. Our example uses the logarithmic utility function with time preference parameter ρ and leisure preference parameter α:[18]

$$(13) \qquad U = \int_o^D \log C_t \, e^{-\rho t} \, dt + \alpha \int_o^D \log \ell_t \, e^{-\rho t} \, dt$$

For purposes of this calculation we consider a continuous time period model in which individuals live for D years. D equals 55 in the calculations. If we take age 18 as the age of adulthood, then an age of death of 55 corresponds to a real world age of death of 73. The ℓ_t terms in (13) are units of leisure at different points in time. The calculations underlying Table I are presented in Appendix A.

While we have not mentioned productivity growth up to this point, it is easy to demonstrate that introducing labor augmenting productivity growth changes none of the formulae; rather, it simply requires relabeling n everywhere as the population growth rate plus the productivity growth rate. In the case of productivity growth, the steady state is characterized by a constant level of transfers per effective worker.

The figures in Table I indicate that the response of consumption and labor supply can be quite important in determining the final partial equilibrium effect of a reduction in transfers when the interest rate differs from the economy's growth rate. For the specific logrithmic function chosen here, a real interest rate which is one percent higher than the rate of population plus productivity growth generates total wealth response numbers approximately equal to .7. If, on the other hand, the rate of population plus productivity growth exceeds the real interest rate by one percent, reducing transfer wealth by one dollar reduces aggregate wealth by one dollar and forty cents.

For the U.S. the annual rate of population growth has averaged 1.40 percent from 1900 through 1974, the period of this study.[19] Productivity growth as measured by the annual percentage change in real GNP per man-hour has averaged 2.20 percent over this period.[20] Adding 1.4 to 2.2 yields 3.6 percent as the rate of population plus productivity

Table 1

Value of $(1 - \frac{\partial M}{\partial T} - \frac{\partial C}{\partial T})$ For The Logarithmic Utility Function

r	n	ρ	$1 - \frac{\partial M}{\partial T} - \frac{\partial C}{\partial T}$
.01	.01	.01	1.00
.01	.02	.01	1.37
.01	.03	.01	1.91
.01	.03	.03	2.09
.01	.04	.01	2.74
.02	.01	.02	.73
.02	.01	.03	.71
.02	.02	.02	1.00
.02	.03	.02	1.40
.02	.04	.02	2.00
.02	.05	.02	2.92
.03	.01	.03	.52
.03	.01	.01	.58
.03	.01	.05	.48
.03	.02	.03	.71
.03	.03	.03	1.00
.03	.04	.03	1.43
.03	.05	.03	2.09
.03	.05	.01	1.91
.03	.05	.05	2.24
.04	.01	.04	.36
.04	.01	.01	.45
.04	.01	.07	.30
.04	.02	.04	.49
.04	.03	.04	.70
.04	.04	.04	1.00
.04	.05	.04	1.46
.04	.06	.04	2.17
.05	.01	.05	.25
.05	.01	.01	.37
.05	.01	.08	.20
.05	.02	.05	.34
.05	.03	.05	.48
.05	.04	.05	.68
.05	.05	.05	1.00
.05	.06	.05	1.49
.05	.07	.05	2.24
.05	.07	.01	1.91
.05	.07	.08	2.42

growth. In this paper we calculate a portfolio weighted net nominal rate of return for the U.S. economy from 1900 through 1974 (see Table B1). After subtracting inflation, the real annual net rate of return in the U.S. economy averaged 4.5 percent over the period 1900 to 1974.[21]

These figures suggest that the value of r has exceeded the value of n in recent U.S. experience. Table II provides decade averages for population growth, productivity growth, and real net interest rates.

Table II

Decade Averages of Population and Productivity Growth Rates and Rates of Return

Period	Average Population Growth (1)	Average Productivity Growth (2)	(1)+(2)	Average Real Net Interest Rate
1900-1910	.020	.016	.036	.061
1911-1920	.013	.004	.017	.037
1921-1930	.015	.023	.038	.098
1931-1940	.007	.031	.038	.055
1941-1950	.013	.030	.043	.010
1951-1960	.017	.026	.043	.055
1961-1970	.013	.030	.043	.024
1971-1975	.009	.017	.026	-.027
1900-1975	.014	.022	.036	.045

Averages of real after tax rates of return exceed growth rates for each of the pre-World War II periods; this relationship is reversed for the post-war period with the exception of the 1950s.

Another method of estimating the difference between n and r is to invoke the steady state relationship that n-r equals the difference between aggregate annual net earnings plus government transfers and aggregate annual consumption divided by the stock of wealth. We detail our sources for these series below. The average annual value for this ratio for the period 1929 to 1974 was -.0061, supporting the view that r has slightly excluded n during this century.

The fact that real interest rates have on average exceeded growth rates suggests that part of U.S. consumption and leisure may well have been financed by interest earned on intergenerational transfers. Hence, a dollar reduction in transfer wealth can be expected to reduce aggregate wealth by less than one dollar. The calculated one percent gap between r and n in conjunction with the numbers in Table I suggests that eliminating transfer wealth in the U.S. economy would reduce total wealth by about 70 percent of the amount of transfer wealth. While the 70 percent figure is meant to be suggestive, rather than precise, it appears that almost any choice of preferences would yield offset factors not far from 70 percent.[22]

To summarize this section, we have demonstrated how total U.S. wealth holdings can be divided into transfers wealth and life cycle wealth components. We have also indicated, using an illustrative utility function, how changes in the size of transfer wealth can be expected to alter steady state wealth holdings in partial equilibrium. We now turn to the task of estimating the magnitudes of transfer and life cycle wealth in the U.S. economy.

II. The Estimation of Life Cycle Wealth - Methodological Approach

Total life cycle wealth in the U.S. economy equals the sum over all living persons in the economy of life cycle assets. Each person's life cycle assets correspond to his(her) accumulated earnings less his(her) accumulated consumption where accumulation occurs at the actually realized rates of return. If we had data detailing each person's earnings, consumption, and realized rate of return on assets at each point in time in the past, it would be easy to check whether U.S. wealth holdings could be explained predominantly 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 on a cohort-by-cohort basis. In this paper we treat individuals of each sex within an age cohort as if they were identical. We estimate for male and female age cohorts in 1974 the average excess of after tax earnings plus government transfers 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 is then compared with the 1974 value of total U.S. private net worth.

Life cycle wealth of the age-sex cohort that is age a and sex j (j equals m or f) in 1974, $L_j(a)$ is given by

$$(13) \qquad L_j(a) \equiv \Sigma_{i=18}^{a} [(\bar{E}_j(a,i) + \bar{G}_j(a,i) - \bar{C}_j(a,i)) \Pi_{k=i}^{a}(1+r(a,k))]P_j(a)$$

In equation (13), $P_j(a)$ stands for number of people alive in 1974 who are age a and sex j. The terms $\bar{E}_j(a,i)$, $\bar{G}_j(a,i)$, and $\bar{C}_j(a,i)$ are, respectively, the average after tax earnings, government transfers, and consumption of the age a, sex j cohort at the time its members were age i. 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.[23] r(a,k) is the economy-wide annual net nominal interest rate received by the age a cohort during the year the members were k years old.

Our estimate of total life cycle assets in the economy in 1974 equals the sum over all age-sex cohorts of the estimated values of $L_j(a)$.[24] The difference between life cycle wealth and total U.S. wealth in 1974 is our estimate of transfer wealth.

Calculation of Longitudinal Profiles of Net Earnings, Government Transfers, and Consumption

The essential idea involved in these calculations is to use cross sectional distribution profiles to allocate aggregate flows of net earnings, government transfers, and consumption to different age-sex cohorts in a given year. By performing this computation for each year from 1900 to 1974 we obtain the longitudinal profiles $\bar{E}_j(a,i)$, $\bar{G}_j(a,i)$, and $\bar{C}_j(a,i)$ as i varies.

To illustrate the computation for $\bar{E}_j(a,i)$, we 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 female workers to average earnings of 40 year old male workers in year t.

$\alpha_m(a,t)$ - 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 (14) to solve for $\bar{e}_t$:

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

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

(15) $$\bar{E}_m(a,i) = \bar{E}_m(a,a-(1974-t)) = \bar{e}_t\ g_m(a,t)\ \alpha_m(a,t)$$

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

The procedure for computing the longitudinal profiles of consumption, $\bar{C}_j(a,i)$, is identical to that just described for earnings; we use cross sectional profiles of relative consumption by age and sex to distribute aggregate U.S. consumption in each year to different age-sex cohorts. More precisely, let us define:

$\bar{c}_t$ - average consumption of a 40 year old male in year t

$\pi_m(a,t)$ - ratio of average consumption of males at age a in year t to average consumption of 40 year old males in year t

$\pi_f(a,t)$ - ratio of average consumption of females at age a in year t to average consumption of 40 year old females in year t.

γ_t - year t ratio of average 40 year old female consumption to average 40 year old male consumption

Z_t - total U.S. consumption in year t.

Given information about all other variables, we use equation (17) to solve for $\bar{C}_t$:

(17) $$Z_t = \bar{c}_t \Sigma_{a=18}^{100}(\pi_m(a,t)\ P_m(a,t) + \gamma_t\ \pi_f(a,t)\ P_f(a,t))$$

The terms $\bar{C}_m(a,i)$ and $\bar{C}_f(a,i)$ can now be computed as:

(18) $$\bar{C}_m(a,i) = \bar{C}_m(a,a-(1974-t)) = \bar{c}_t\ \pi_m(a,t)$$

(19) $$\bar{C}_f(a,i) = \bar{C}_f(a,a-(1974-t)) = \bar{c}_t\ \gamma_t \pi_f(a,t)$$

Calculation of Net Nominal Interest Rates Series

The interest rate term r(a,i) depends only on the year t since $r(a,i) = r(1974-(a-i)) = r(t)$. We computed two different interest rate time series, series I and series II, using two quite different methodologies. Series I was calculated by dividing U.S. wealth holdings into six separate assets, calculating a rate of return series for each asset, and then weighting each asset's rate of return by its share in the U.S. portfolio for the particular year in question.

Series II is based on the wealth augmentation relation:[25]

$$W_{t+1} = W_t(1+r_t) + H_t + G_t - Z_t \tag{20}$$

Equation (20) indicates that private U.S. net worth in year t+1 equals U.S. net worth in year t, plus savings in year t. Savings in year t is, in turn, equal to income on assets, r_tW_t, plus after tax labor income and government transfers, H_t and G_t, less aggregate consumption in year t, Z_t.

To obtain our Series II interest rates we solve equation (22) for r_t and compute values for r_t using time series data on W_t, H_t, G_t, and Z_t.[25]

III. Description of the Data Used To Calculate Life Cycle Wealth

Bureau of the Census estimates of the U.S. population by age and sex for every year from 1900 through 1974 is one of the key pieces of information used in our analysis.[26] These population numbers are used in equations (14) and (17) to generate the terms $\bar{E}_j(a,i)$, $\bar{G}_j(a,i)$, and $\bar{C}_j(a,i)$; they are also used in (13) to compute each age-sex cohort's total life cycle wealth, $L_j(a)$.

Information on compensation of employees after 1929 is obtained from the National Income Accounts.[27] For the years 1909 to 1929 we use estimates from Kuznets and Levin et. al. For years prior to 1909 employee compensation is imputed from Kendrick's estimates of net national product using the ratios of employee compensation to national product for the years 1909 to 1918.[28] To impute labor income to the self employed we follow Kravis (1959) and Christensen (1971) and multiply the numbers of proprietors by the average earnings of full time equivalent employees.[29] Christensen (1971) discusses possible biases resulting from this type of imputation.[30] The chief bias is simply that the self-employed may earn more or less on average than employees. A second bias is that our enumeration of the self employed does not include unpaid family workers in family enterprises. To insure that our results do not reflect a substantial underestimate of entrepreneurial earnings, we increase our estimate of entrepreneurial earnings for each year by 20 percent in our calculations.

Our series on employee compensation and labor income of the self employed (without the 20 percent add on factor) are reported in Appendix B, Table B1.

Estimates of state and federal income taxes paid on labor income were obtained from IRS Statistics of Income and The National Income and Product

Accounts.[31] Combined employer and employee social security and health insurance taxes were obtained from the Social Security Annual Statistical Supplement for various years.[32]

Estimates of the age earnings profiles for men and women were obtained by fitting separate regressions to social security estimates of median annual earnings of workers at different ages for the years 1950 through 1975.[33] 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 1950-1975 period. For the years prior to 1950, the predicted male and female age-earnings profiles for the year 1955 were used.[34]

The value of λ_t, the ratio of average earnings of 40 years old female workers to average earnings of 40 year old male workers in year t was taken to be .55 throughout the period. This appears to be an upperbound value for λ_t which will also bias our results towards more life cycle savings.[35]

Values for work experience rates by age and sex, $\alpha_m(a,t)$ and $\alpha_f(a,t)$, are available only after 1959.[36] 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 work experience rates can be predicted quite closely by functions of age and labor force participation rates. We chose, therefore, to use this regression to estimate the α function for each year from 1900 to 1974 by inserting the appropriate year specific labor force participation rates.[37] The labor force participation rates equal the values predicted from regressions of labor force participation rates on fifth order age polynomials for each sex and for different census years.[38]

While we computed cross-sectional distribution functions by sex and age for social security and medicare transfers, we could not find data with which to compute these distributions for other types of transfers.[39] Hence, we assumed that these other transfers which include veterans' benefits and welfare payments were distributed in the cross-section according to the age earnings distributions.[40]

Total consumption expenditure, Z_t, is taken from National Income Accounts after 1929 and from Kendrick prior to 1929.[41] 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. In any case, there appears to be very little difference between the consumer expenditure series and the true economic consumption series.[42]

To calculate the cross-sectional consumption distribution functions $\pi_m(a,t)$ and $\pi_f(a,t)$ which appear in equation (17), we made extensive use of the 1960 and 1972-73 Consumer Expenditure Survey (CES) tapes. The 1972-73 survey indicates total household consumption as well as the ages and sexes of all household members. The 1960 survey provides more limited information about the age-sex composition of the household.[43]

Using the 1972-73 tape, we divided total household consumption between the individuals in the household in a manner we discuss below. We then pooled these individual consumption expenditure numbers across all households and calculated weighted averages of consumption for each age and sex;[44] the weights we used are the CES population weights. We then fit separate age polynomials to these average consumption figures to generate the profiles of relative consumption by age, $\pi_m(a,t)$ and $\pi_f(a,t)$.[45]

In distributing total household consumption to household members we assumed that household heads and their spouses consumed equally; all other household members, including children, were allocated fifty percent of the household head's consumption. Having allocated a level of consumption to each household member, we then reallocated the total consumption of children under the age of 18 to the household head and spouse, assigning each one half of children's consumption in the case of two spouses, or giving all the children's consumption to the head if he(she) was single. The general shape of the profiles was quite insensitive to whether we assumed that other household members and children consumed the same or only 50 percent of the consumption level of the household head. The 50 percent assumption generated slightly more life cycle wealth and is, therefore, the one we present.

In order to make similar use of the 1960 CES tape we imputed missing information about the sexes and ages of other household members from information derived from the 1972-73 CES tape.[46] Figures I and II present the male and female relative consumption profiles that we constructed. The profiles for the two periods are quite similar for both the males and the females. Unfortunately, similar data is not available to generate these profiles for earlier years.[47] Hence, we are forced to assume that the cross-sectional age consumption profile for the earlier years had a shape similar to that of the profiles in latter years. Life cycle wealth is computed using the 1972-73 cross-sectional profiles throughout the period 1900 to 1974. The 1960 profiles generated essentially the same level of life cycle wealth.[48]

As an additional check that our CES consumption profiles were generally accurate, we also used the 1962 Federal Reserve Survey of Consumer Finances

FIGURE I

Male Relative Consumption by Age, 1972-1973 and 1960 Profiles

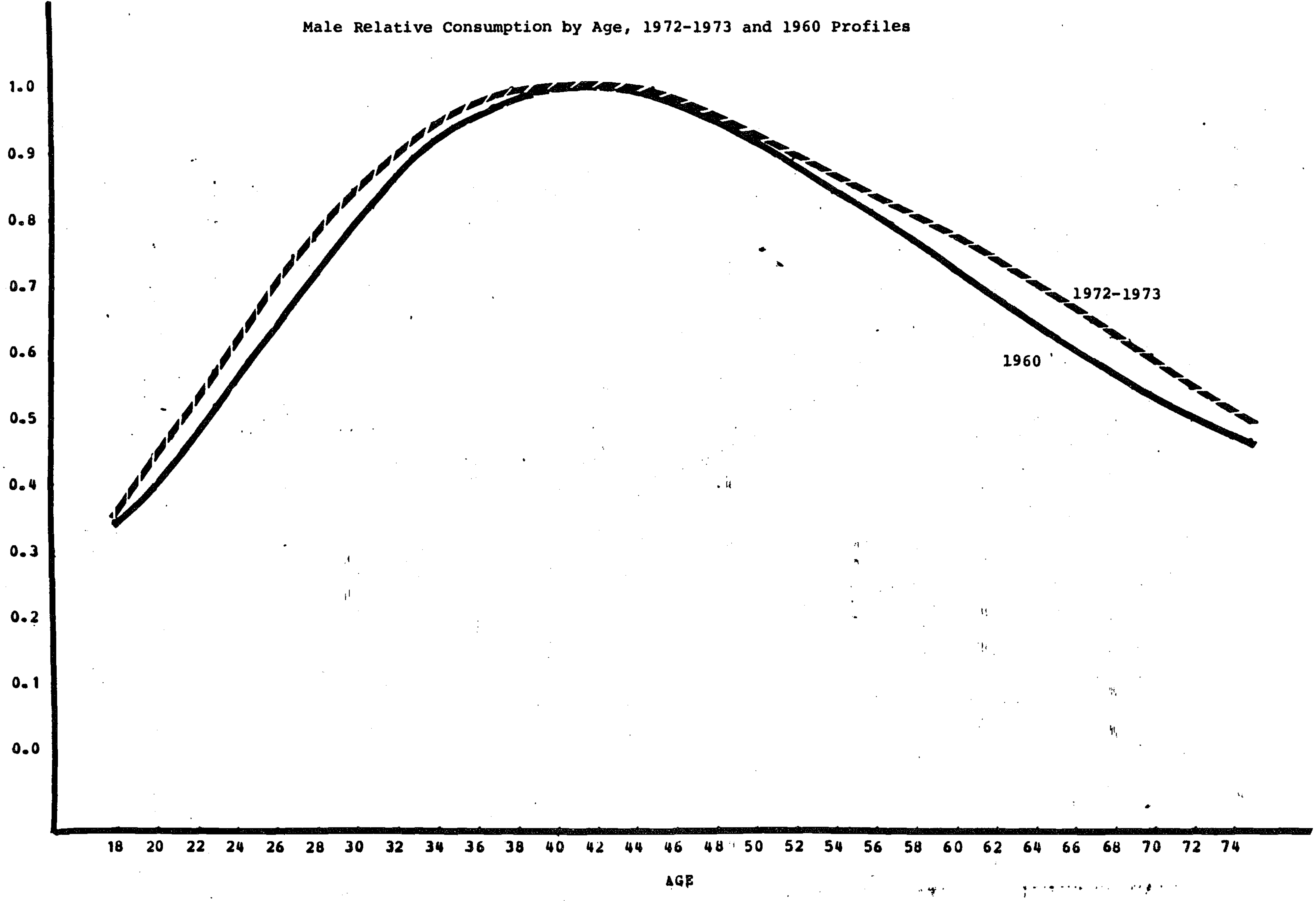
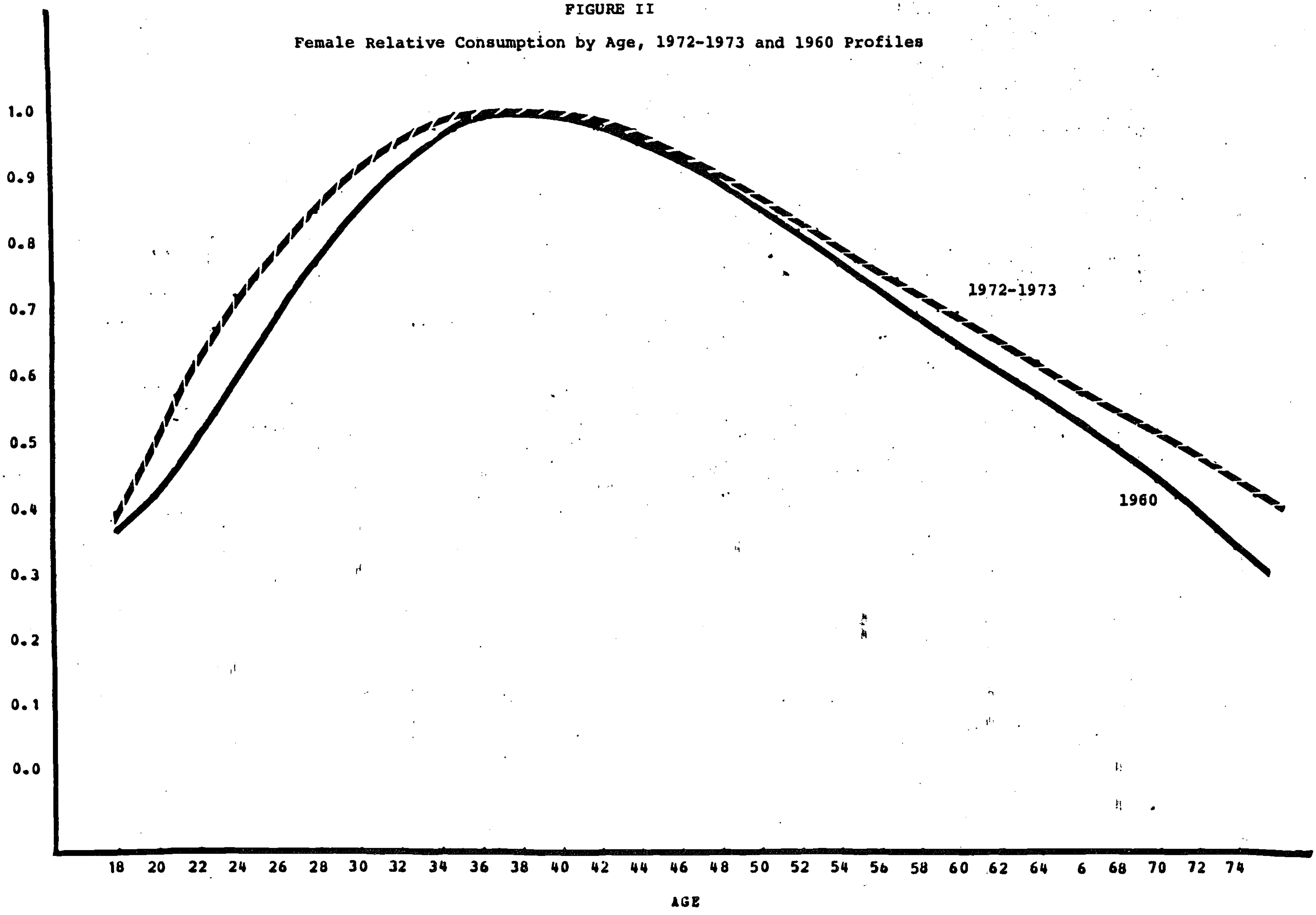


FIGURE II

Female Relative Consumption by Age, 1972-1973 and 1960 Profiles



to construct profiles of relative consumption by age. The Federal Reserve Survey does not report consumption directly, so we estimated consumption as the difference between income and savings. As with the 1960 CES tape, we imputed age and sex information for other household members. The Federal Reserve profiles are generally quite similar in shape to the CES profiles.[49]

Our net nominal interest rate series I is constructed using data on historical rates of return and data from Goldsmith on portfolio shares. From Goldsmith's balance sheets we generate seven asset categories plus liabilities.[50] These are tangible, non-corporate business assets including land and structures, residential 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.[51] Rates of return on stocks from 1926-1974 are reported in Ibbotson and Singuefield (1976). Prior to 1926 we assume a 5 percent dividend and add in the capital gain on stocks indicated by the Standard and Poor's Index.[52] 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 percent 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.[53] 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 percent.[54]

The return to residential land and structures was computed in two parts. The nominal capital gain was calculated after 1929 as the percentage increment in the GNP price deflator for fixed investment.[55] Prior to 1929 we use Goldsmith's series on the value of one family houses.[56] The own rate of return to home ownership was estimated as the ratio of NIA imputed rent to the value of owner-occupied housing and residential land.[57] These series are available only after 1946. The computed own rate of return to home ownership from 1946 through 1974 averaged .0409. We use this number as the own rate to home ownership for the period 1900 through 1946. Finally, we assumed that the rate of return to non-corporate tangible business assets equaled the overall rate of return to all other assets.

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.[58]

Our second net nominal interest rate series, series II, was computed for the post-1929 period using equation (22). We have already described sources for the series H_t, G_t and Z_t. Reliable net worth data are not available until 1929. For the period 1929 through 1950 Munnell and Evans report Andos' updated version of Goldsmith's original net worth series. After 1951 the wealth series comes from the FRB-MIT data bank.[59] The wealth series are constructed, in part, by use of the perpetual inventory method in conjunction with initial benchmark estimates of the stocks of different types of assets.

The interest rate series I and II are reported in table B1 in Appendix B. Over the period 1900-1974 the series I interest rates averaged 6.43 percent. From 1929-1974 series I averaged 5.43 percent, while the series II rates averaged 5.74 percent. The correlation between the two series for this period is .665. The fact that the series II interest rates exhibit reasonable magnitudes and correlate well with the series I rates reassures us that our 1974 aggregate U.S. net worth number can be compared with our accumulated flows, although the net worth and aggregate flows numbers came from fairly different sources. In our computations we fill in the series II rates with the series I values for the years 1900-1928.

IV. The Size of Life Cycle Wealth

At the end of 1974 total net worth in the U.S. economy equaled 4.154 trillion dollars. Of the 4.154 trillion, 134 billion dollars represents the tangible assets of non-profit institutions;[60] in 1974 non-profit institutions owned 4.4% of corporate equities.[61] If we assume that this same percentage applies to all other financial assets, total net worth of non-profit institutions in 1974 would equal \$270 billion.[62] Subtracting \$270 billion from \$4154 billion leave us with a 1974 net worth figure for the non-institutional household sector of \$3.884 trillion. This is the number which we compare with our life cycle wealth calculations.

In addition to presenting total life cycle wealth of individuals, which we call LCWI, we also present values of a second life cycle wealth concept, LCWII, which adds to LCWI an upper bound estimate of accumulated inter-spousal transfers. Many economists would include within their definition of life cycle wealth the amount of accumulation that arises from inter-spousal transfers. Inter-spousal transfers gives rise to wealth accumulation first because wives are on average younger than husbands and, secondly, because females live longer than males. Since it is conceptually difficult, if not impossible, to exactly trace individual patterns of household formation which involve marriage, divorce, and death, we added to LCWI what we believe to be an upper bound estimate of the stock of interspousal accumulated transfers. To be specific, we assumed that all males became married at age 21 to females who were at the time age 18.[63] If either spouse died prior to reaching age 75, all of his or her individual life cycle net worth was assumed to be transfered to a surviving spouse; it was furthermore assumed that the surviving spouse does not die prior to age 75. Thus, for example, if a 40 year old male dies in 1960 with $20,000 of life cycle wealth, this $20,000 is transferred to a 37 year old female who is assumed still to be alive 14 years later in 1974. The $20,000 of received transfers is accumulated up to 1974 at the prevailing interest rates.

This procedure overestimates accumulated inter-spousal transfers for three reasons. First, not all transfers of decedents go to surviving spouses, or even to surviving relatives in the same age cohort. Secondly, not all surviving spouses will, themselves, live until age 75. Rather, many will die much earlier, leaving the bulk of their residual wealth to children or grandchildren. Third, some decedents die without ever having married, leaving their estates to younger cohorts.

Table III reports the life cycle wealth numbers, LCWI and LCWII, that we calculated using interest rate series I and series II, as well as constant interest rates of 2, 4, 6, 8, and 9 percent. The series I values for

LCWI and LCWII are, respectively, -1036 and 502 billion dollars. The series II figures are -1229 and 733 billion dollars. These figures are strikingly small; they are even more surprising in light of the fact that we have made a number of assumptions which would bias our calculation towards more life cycle wealth.[64] Under the stricter definition of life cycle wealth, LCWI, life cycle accumulated hump savings is a large, negative number. The allowance for inter-spousal transfers yields positive, but very small estimates of hump savings. The 733 billion dollar series II LCWII figure for life cycle wealth represents only 19 percent of the total 1974 U.S. wealth. Accumulated intergenerational transfers would, then, appear to represent the bulk of the 3884 billion dollars of U.S. wealth holdings in 1974. By subtracting 733 from 3884 we arrive at 3151 billion dollars as the estimate of the 1974 stock of transfers wealth. Taking the .7 (r exceeds n by about one percent) adjustment factor as illustrative, entirely eliminating intergenerational transfers would reduce U.S. wealth by about 2.2 trillion dollars in the context of a partial equilibrium, long run steady state model.

Table III

Accumulated Life Cycle Wealth
(in billions)

Life Cycle Wealth Concept	Interest Rates						
	Series I	Series II	.02	.04	.06	.08	.09
LCWI	-1032	-1229	-270	-520	-1108	-2526	-3882
LCWII	502	733	186	300	446	565	557

These small values for life cycle wealth do not appear to reflect the choice of interest rates; no historically reasonable constant nominal interest rate will yield significant positive life cycle wealth.

To explain the large stock of U.S. wealth the life cycle theory of savings must rely on a substantial excess of earnings over consumption when young followed by an excess of consumption over earnings when old. The historical reality for the U.S. is simply that longitudinal earnings and consumption profiles have not exhibited the kinds of shapes required for substantial life cycle accumulation. For males, earnings profiles greatly exceed consumption profiles over most of the life cycle. For females, however, the opposite is true. Life cycle wealth starts out negative and remains negative all over ages. In figures III-VIII we graph longitudinal profiles of the sum of male and female average earnings plus government transfer and average consumption for the different age cohorts. The profiles are presented in real 1967 dollars. The diagrams clearly show that the male excess of earnings over consumption is essentially offset by the female excess of consumption over earnings.

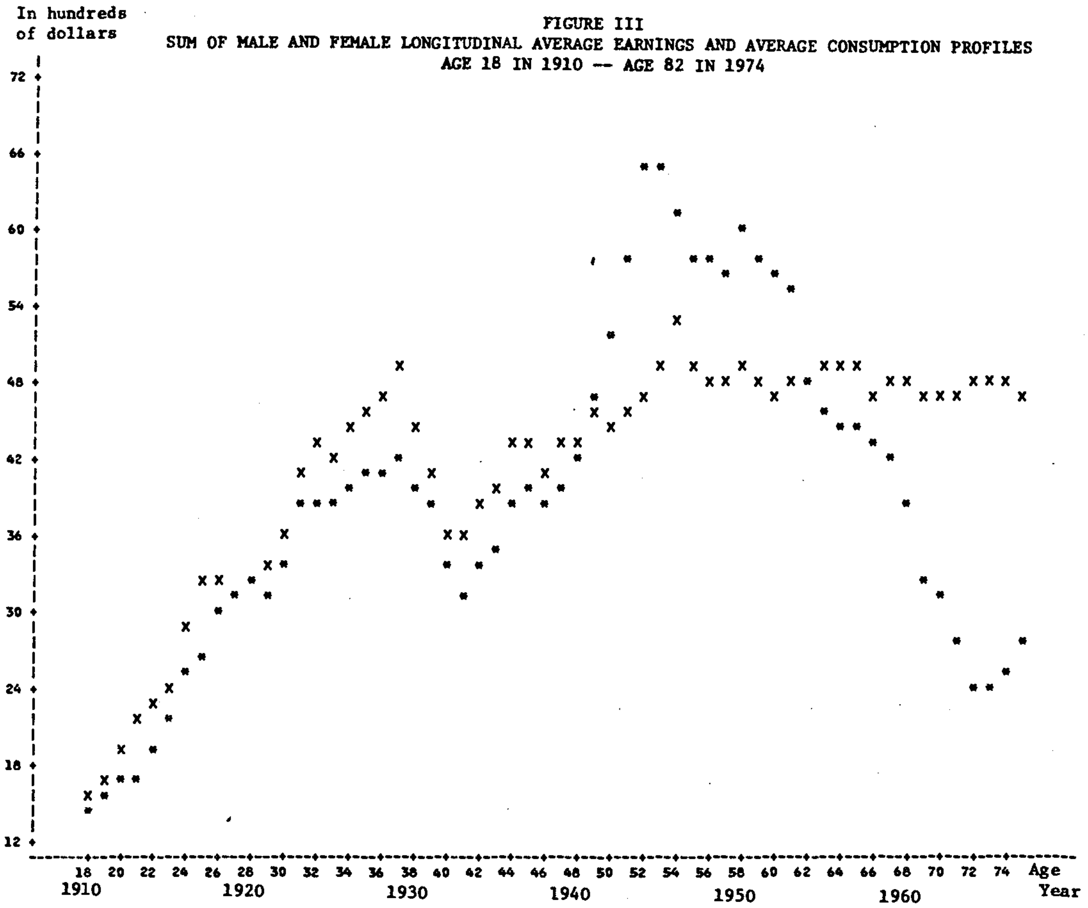
Contrary to the life cycle simulation studies which have generated substantial life cycle wealth, the actual growth rate of lifetime consumption does not substantially exceed the actual growth rate in lifetime earnings.[64b] For example, the male age cohort that reached age 18 in 1920 experienced a growth rate of 2.93 percent in real earnings between ages 18 and 65. In comparison, the male growth in real consumption between ages 18 and 72 was only 2.32 percent. For the corresponding female cohort, earnings growth was 2.23 percent and consumption growth only 1.72 percent. Real consumption profiles are fairly flat, and real earnings profiles peak in the late middle ages, not at early ages. Both of these factors militate against the life cycle theory of savings as an explanation of U.S. wealth holdings.

The positive male and negative female life cycle wealth values generated by these profiles are displayed for a number of age-sex cohorts in table IV. The table presents life cycle wealth values for both the LCWI and LCWII

FIGURE III

SUM OF MALE AND FEMALE LONGITUDINAL AVERAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES

AGE 18 IN 1910 -- AGE 82 IN 1974

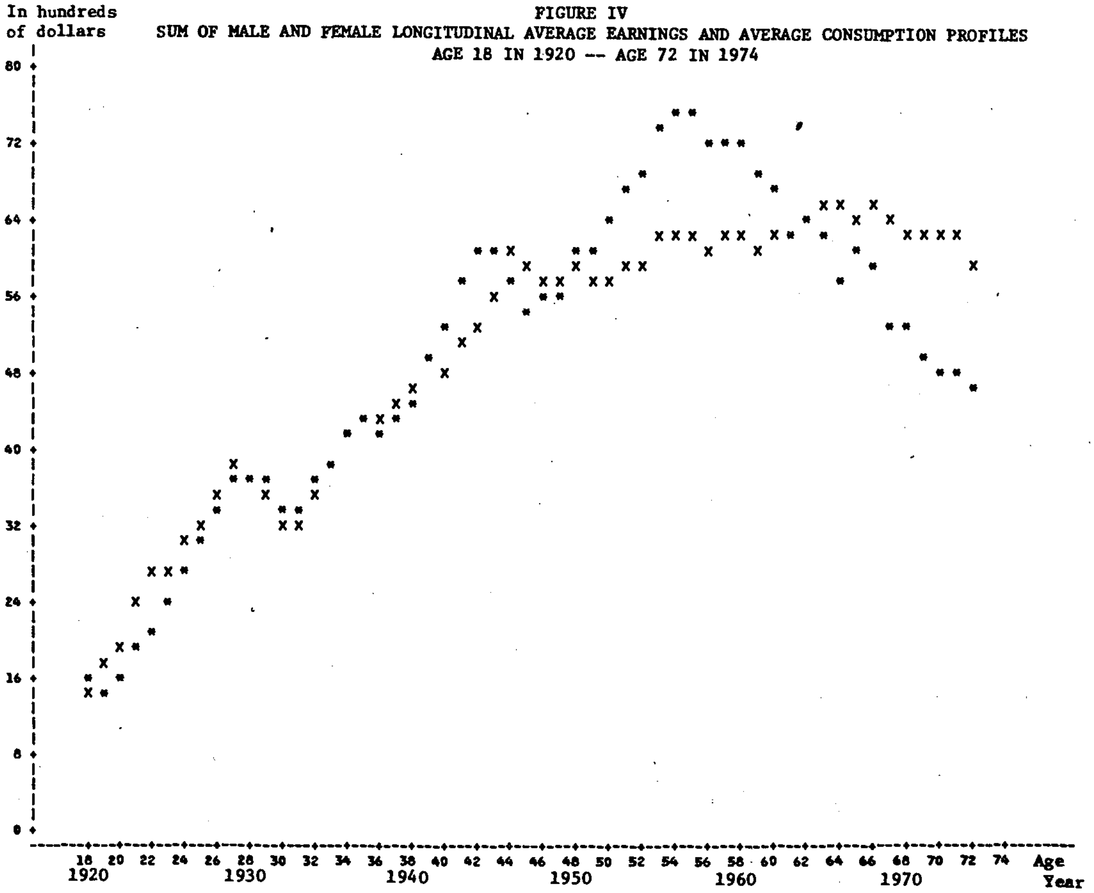


NOTE: * = earnings, x = consumption

FIGURE IV

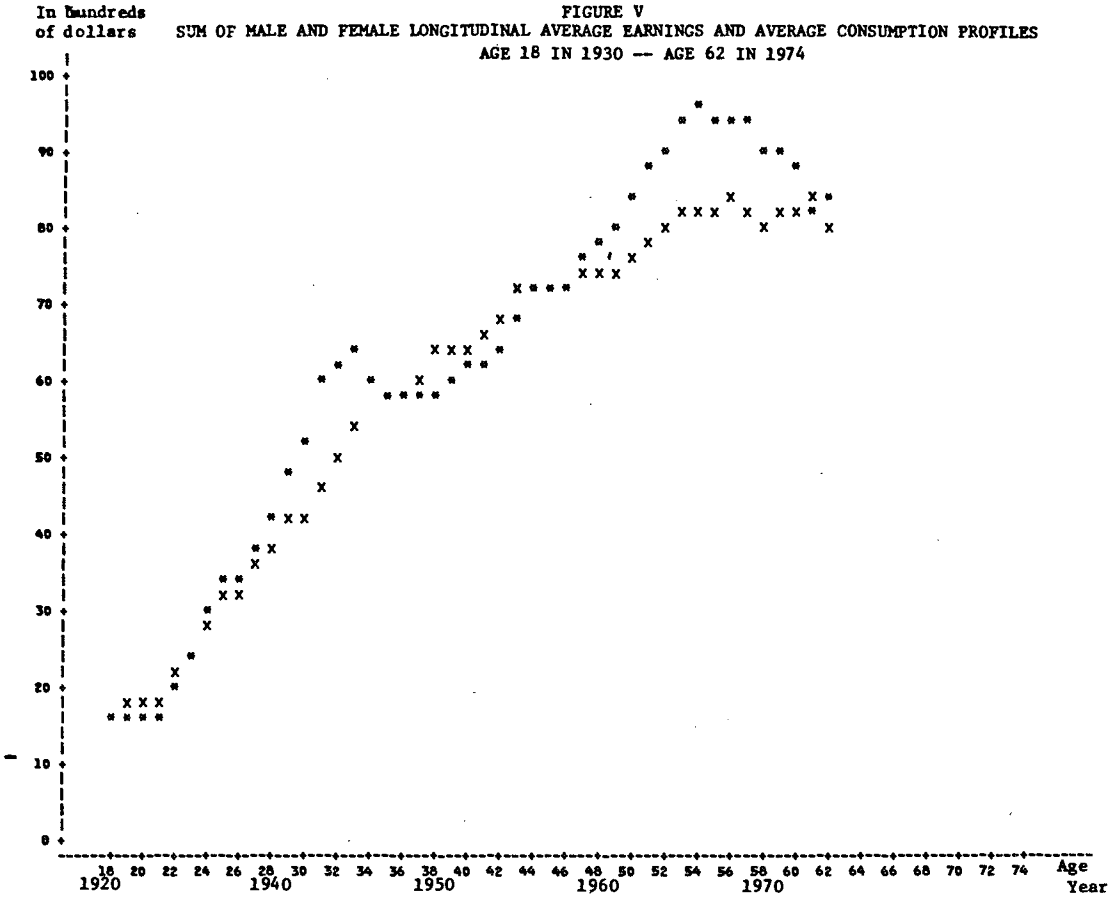
SUM OF MALE AND FEMALE LONGITUDINAL AVERAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES

AGE 18 IN 1920 -- AGE 72 IN 1974



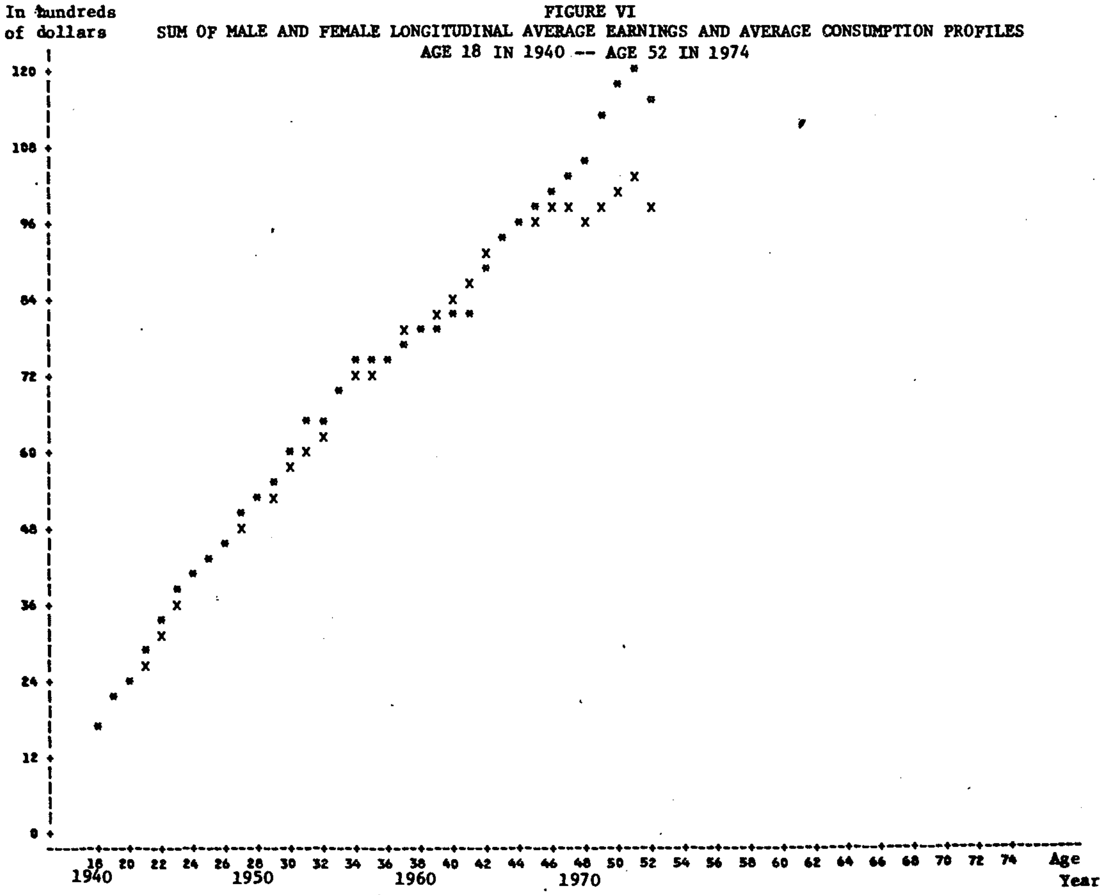
NOTE: * = earnings, x = consumption

FIGURE V
SUM OF MALE AND FEMALE LONGITUDINAL AVERAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES
AGE 18 IN 1930 -- AGE 62 IN 1974



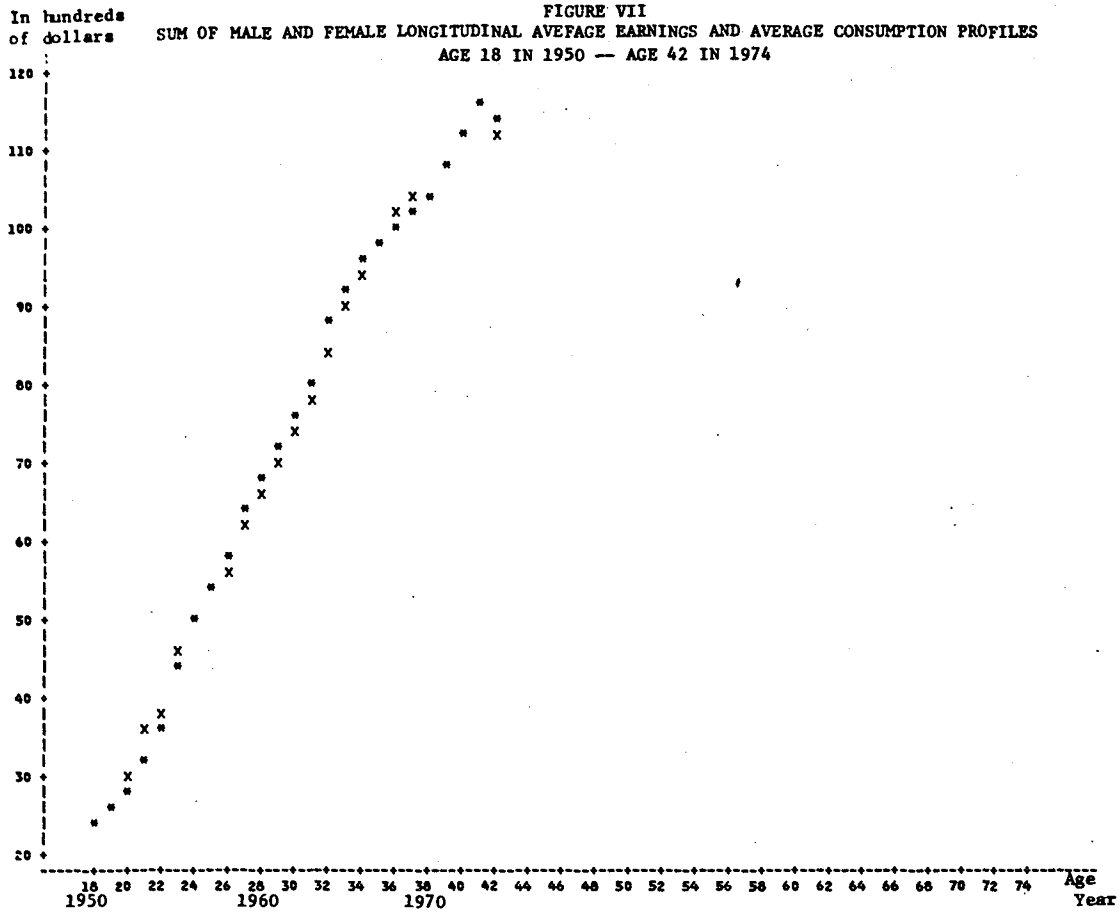
NOTE: * = earnings, x = consumption

FIGURE VI
SUM OF MALE AND FEMALE LONGITUDINAL AVERAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES
AGE 18 IN 1940 -- AGE 52 IN 1974



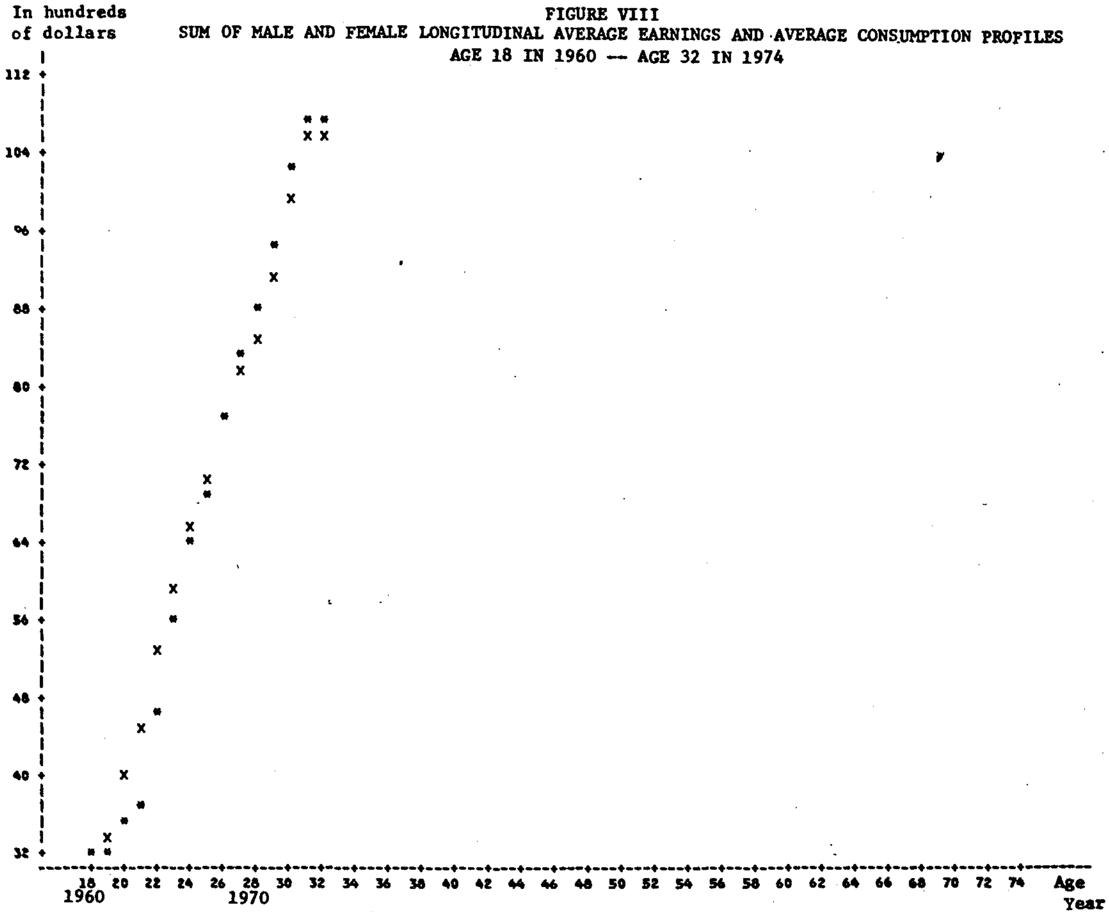
NOTE: * = earnings, x = consumption

FIGURE VII
SUM OF MALE AND FEMALE LONGITUDINAL AVEFAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES
AGE 18 IN 1950 — AGE 42 IN 1974



NOTE: * = earnings, x = consumption

FIGURE VIII
SUM OF MALE AND FEMALE LONGITUDINAL AVERAGE EARNINGS AND AVERAGE CONSUMPTION PROFILES
AGE 18 IN 1960 — AGE 32 IN 1974



NOTE: * = earnings, x = consumption

concepts. For males the LCWII values are smaller than the LCWI values because the hypothetical spousal transfers from decedent females to surviving males are negative. Males, however, generally die with positive life cycle wealth which leads to greater life cycle wealth (LCWII) for females when this male wealth is passed on to surviving female age cohorts.

Table IV
1974 Total Life Cycle Wealth By Age Sex Cohort
(in billions)

	LCWI		LCWII	
Age in 1974	Males	Females	Males	Females
20	-2.00	-2.53	-2.00	-2.54
25	2.56	-12.90	2.55	-12.85
30	22.55	-28.45	22.49	-28.09
35	39.18	-42.39	39.00	-41.32
40	58.09	-59.58	57.57	-56.73
45	84.16	-85.36	82.83	-78.40
50	113.91	-107.68	110.53	-92.64
55	135.13	-117.08	124.79	-89.15
60	135.13	-120.27	123.29	-73.66
65	126.08	-131.55	105.75	-61.77
70	97.02	-124.71	61.14	-25.18
75	69.79	-118.71	10.46	1.78
80	56.60	-104.18	-33.73	30.65
Total All Ages	4892.54	-5925.04	3014.41	-2512.60

Table is based on the Series I interest rates.

The large transfer wealth value of 3.151 trillion cannot simply be explained as private transfers from old to young offsetting forced government social security and medicare transfers from young to old. Under the Barro (1974) view, introducing unfunded social security into an economy will lead to no change in consumption, but will increase private net transfers from old to young. If Barro's view is correct, we can easily ask how large private transfers would have been with no Social Security and medicare system by simply setting all historic social security and medicare benefits and taxes to zero in our calculation. This procedure led to a series I value of 775 billion and a series II value of 1094 billion for LCW II. Hence, even if Barro is correct in his view about unfunded social security, transfer wealth would still have exceeded 2.79 trillion dollars in 1974 if there had never been a social security program.

One possible problem with our calculations is that the age consumption profiles prior to 1960 may have looked substantially different from those after 1960. We examined this issue by altering the shape of the cross-sectional age consumption profile. To be precise, relative consumption prior to age 40 was reduced by 10 percent and relative consumption after age 40 was increased by 10 percent. Thus , 60 year olds were effectively assigned an extra 20 percent consumption relative to 30 year olds in every year from 1900 to 1974. Altering consumption profiles in this manner produced values of -193 for LCWI and 1702 for LCWII using series I and -169 for LCWI and 2178 for LCWII using series II. These numbers are still quite small relative to the 3884 billion dollars of 1974 U.S. net worth.

Another issue of concern is whether our data series on aggregate flows accurately describe U.S.experience in the 1900s. As mentioned, to insure against under-estimation of the labor income of the self-employed, we have already increased our estimates (see Table B1) by 20 percent. Raising this add on factor to 30 percent increases the series I values of LCWI to -679 and LCWII to 872. It is worth noting that eliminating any self-employment add on factor lowers LCWI to -1739 and LCWII to -714. A second data problem is the well known failure of the National Income Accounts to impute wages for non-contracted household production, such as mowing the lawn and cleaning the dishes. However, this under-enumeration of earnings must be set against the equal under-enumeration of consumption, since consumption expenditures on the lawn and dishes do not enter the national accounts either. In our calculation these types of errors concerning the size of earnings flows will be offset by errors concerning the size of consumption flows.

Assuming other features of the national accounts were correctly estimated, large non-cancelling errors in NIA reported flows of consumption and compensation of employees would imply large values for the statistical discrepancy in the accounts. In fact, the statistical discrepancy has been and is extremely small. In 1974 the statistical discrepancy was only -.6 billion dollars.

A final data issue concerns consumption expenditures of non-profit institutions as well as contributions of individuals to such institutions. Ideally we should subtract institutional consumption from aggregate consumption and add contributions to these institutions to arrive at total household consumption. While not all the data needed for this adjustment is available, what data is available suggests that the adjustment would be very small, and would slightly lower our estimate of life cycle wealth.[65]

Our LCWII wealth concept effectively deals with possible bias arising from differential survival probabilities between the rich and the poor. This calculation assumes that at least one member of each household survives to age 75 and attributes all household life cycle accumulation to the surviving spouse(s). Hence, this procedure assumes that rich and poor households have identical survival probabilities, which eliminates this issue of bias.

Another type of aggregation error could arise if some households continually received higher rates of return on their assets than other households. In order to investigate this issue one would need detailed knowledge of the joint distribution of rates of return and household consumption and earnings patterns. Unfortunatley, this information can not be obtained from existing micro data, and this fact precludes a reasonable assessment of the magnitude of this source of error.

V. Explaining the Residual -- The Stock of Transfer Wealth

This section investigates the extent to which U.S. data on intergenerational transfers can explain the large residual between total U.S. net worth and our estimates of life cycle wealth. The residual is, indeed, quite large.

Unfortunately, there is very little data detailing non-taxed intergenerational transfers. These non-enumerated transfers take many, many forms. Parents who lend money at below market rates to their children for a down payment on a house or a business are engaged in an intergenerational transfer. A father who makes his son a full partner in a lucrative business can effectively transfer large sums of money with no tax liability to the IRS. Parents who fully or partially support their children through college or after college are making transfers. A grandmother's gift of her expensive wedding china and rings to her granddaughter is an intergenerational transfer. Transfers in these forms, as well as outright monetary gifts, are very rarely reported.

To obtain some idea about how large aggregate intergenerational transfer flows need to be in order to explain a 3.151 trillion dollar stock of transfer wealth, consider the multiperiod analogue to equation (8) which we develop in appendix A, equation (a2), and rewrite here:

$$T = t\,\frac{e^{(r-n)D}}{(r-n)}\,(1-e^{(n-r)(G-I)}) \tag{23}$$

Equation (23) is a simplified expression for the steady state stock of transfers; the formula assumes that all transfers are given at age G and received at age I. t is the yearly flow of intergenerational transfers, D is the certain age of death, and r and n are respectively rates of interest and population plus productivity growth. In the case $r=n$, this expression reduces to $T=t(G-I)$, the analogue to equation (9). Table V evaluates the age gap factor, i.e., the terms multiplying t for various parameter values and taking D to be 55.[65]

Table IV

The Age Gap Factor

	r-n					
Age Gap (G-1)	-.02	-.01	0	.01	.02	.03
20	8	13	20	31	49	78
25	11	16	25	38	59	92
30	14	20	30	45	68	103
35	17	24	35	51	76	113

To get a feeling for what these age gap factors mean, consider an age gap of 30 and a .01 excess of the interest rate over the population plus productivity growth rate. Exactly which age gap is appropriate is unclear.[67] An age gap of 30 would allow for some significant transfers to grandchildren as well as children. The age gap factor for these parameters is 45. Hence, to explain 3151 billion dollars in transfer wealth the yearly flow of transfers would have to equal 3151 billion divided by 45, or 70 billion dollars. A 2 percent differential between (r-n) again assuming a 30 year gap, would require only a 46 billion dollar annual transfer flow.

To estimate at least the bequest portion of the yearly transfer flow we made use of the 1962 Federal Reserve Survey of Consumer Finances. Specifically, we first determined the distribution of net worth holdings by age, sex, and marital status. We then applied 1962 mortality probabilities to this distribution to arrive at an estimated distribution of bequests by age, sex, and marital status.[68] Effectively, this procedure involves hypothetically killing off the people on the tape according to mortality probabilities. An additional adjustment to these figures was made in order to reconcile the U.S. aggregate net worth value estimated from the Federal Reserve tape with the RFT-MIT net worth data.

Paul Menchik provided us with data from the Washington, D.C. Inheritance Tax File for the year 1967. The data reveal that males who were married at the time of their death left 10 percent of their estate to their children. Married female decedents left 19 percent of their estates to their children. The proportion left to grandchildren and other young relatives is unclear, but it probably does not exceed 2 percent for males and 4 percent for females, which represents half of the percentage contribution to other relatives. For single male decedents 32 percent of the estate is left to children; the single female proportion is 37 percent. Again taking half of the contributions to other relatives as "distant in age" intergenerational transfers, another 22 percent can be ascribed to single males and 23 percent to single females. Using these figures and the Federal Reserve simulated bequest distributions the estimated "distant in age" intergenerational bequest transfer flow in 1962 was 11.9 billion dollars. Multiplying this figure by the 221.6 percent growth in the nominal value of total U.S. net worth between 1962 and 1974 gives us an estimate of the 1974 bequest transfer flow of 26.4 billion dollars.

In 1974 the total value of life insurance death benefits equaled 8.885 billion dollars. In conjunction with the Menchik numbers this raises our 26.4 billion bequest flow figure to 28.9 billion.

We also estimate the flow of intergenerational transfers from parents to children which occur in the form of financial support during college. In 1974 college enrollment totaled 8.8 million students.[69] In 1976 parental contributions to college-enrolled children who were taken as tax deductions averaged

$1738.[70] Assuming that non-tax dependent college-enrolled children received one quarter of this level of support, average support from parents in 1976 was $1270. Reducing this number by 15 percent, the growth in tuition between 1974 and 1976[71] suggests a level of college support payments of about $1080 in 1974. This type of intergenerational transfer could then account for 10.3 billion dollars of the total 1974 flow. Adding the 10.3 to the 28.9 leaves us with 39.2 billion dollars of explained transfer flows.

Another component of the intergenerational transfer flow are transfers made in the form of trusts. While we have not been able to locate direct data on the value of new trusts formed in 1974, there is fiduciary income tax data for the years 1965 and 1970 which permits a rough calculation of this transfer flow component.[72] Between 1965 and 1970 the number of new trusts established each year averaged 35,098. The 1970 income of the 152,398 existing trusts in 1970 totaled $7,513 billion. The average 1970 trust had, therefore, an income of $9,985. Dividing this value by our 1970 series I interest rate of .0787 gives an estimate of the average value of a 1970 trust of $126,874. Multiplying this figure by 35,098 leads to an estimate of 4.44 billion as the value of new trusts established in 1974. Multiplying this number by 1.395 to allow for the growth in total wealth between 1970 and 1974, our estimate of the 1974 flow of intergenerational transfers in the form of trusts is 6.19 billion dollars. This figure raises our explained transfer flow to 45.4 billion dollars.

This 45.4 billion dollar figure seems small compared with the 70 billion dollar total flow needed if the stock of transfer wealth is 3.151 trillion dollars and the age gap factor is 45. On the other hand, it is not too far from the 46 billion dollar total flow needed if r exceeds n by 2 percent and the age gap factor is 68.

Unfortunately, before we can more precisely determine the total intergenerational flow, substantially more information will have to be collected about family gift giving and support payments to children and grandchildren. This data may prove particularly difficult to obtain since it would involve valuing the cedar chest passed from grandmother to grand-nephew, or the family car given to son John as a college graduation present, or the value to son Alex of making him a full partner in a lucrative family business. Since the distribution of wealth is very highly skewed, such surveys need to be aimed at the intergenerational transfer payments of the very wealthy. However, the very wealthy may be the least willing to disclose these types of transfers because of potential estate and gift tax liabilities.

Summary and Conclusions

The evidence presented in this paper rules out life cycle hump saving as the major determinant of capital accumulation in the U.S. economy. Longitudinal age earnings and age consumption profiles do not exhibit the kinds of shapes needed to generate large amount of life cycle wealth accumulation. The view of U.S. capital formation as arising, in the main, from essentially homogenous individuals or married spouses saving when young for their retirement is factually incorrect.

Intergenerational transfers appear to be the major element determining wealth accumulation in the U.S. Our best estimates of the 1974 stock of transfer wealth after allowing for inter-spousal life cycle accumulation is approximately 3 trillion dollars. Even after making a quite generous assumption that the self employed have 20 percent higher labor earnings than the non-self employed, we estimate a stock of transfer wealth of at least 3 trillion dollars.

While these estimates of the stock of transfer wealth are quite large, totally eliminating transfers in the U.S. economy would not necessarily reduce total U.S. wealth by the full amount of transfer wealth. We have demonstrated within the contect of a steady state growth model that a dollar reduction in the stock of transfer wealth may reduce total wealth by less than a dollar if the steady state real interest rate exceeds the steady state growth rate. Taking the U.S. historical real interest and growth rates as illustrative, eliminating a 3 trillions dollar U.S, stock of transfer wealth would reduce total U.S. wealth by about 2.1 trillion dollars in a steady state context. This, however, is a partial equilibrium analysis. Substantially more research must be undertaken before we can begin to attach probable numbers to full general equilibrium responses to changes in transfers.

Our paper has important implications for annual U.S. savings as well as the stock of U.S. wealth. In a steady state framework total savings can be divided into a part needed to augment the stock of transfer wealth and a part needed to augment life cycle wealth. To the extent that U.S. life cycle wealth is negligible, the great bulk of annual savings can be attributed to savings for purposes of intergenerational transfers.

This paper suggests the importance of and need for substantially more research and data collection on intergenerational transfers. Economic models of savings which stress the homogeneity of agents and the importance of the demographic structure should give way to models which emphasize the rather massive intergenerational transfers in the U.S. economy and the apparent concentration of these transfers among the very wealthy.

FOOTNOTES

[1] Modigliani and Brumberg (1956).

[2] Tobin (1967) and Boskin (1978) argue that Life Cycle Savings are the predominant form of savings in the U.S. Darby (1979) and White (1978) argue otherwise.

[3] See, for example, Atkinson (1971), Oulton (1976), Diamond (1970), Feldstein (1977), and Kotlikoff and Summers (1979).

[4] See, for example, Diamond (1970), Feldstein (1974), Kotlikoff (1979), and Hall (1978).

[5] See, for example, Feldstein (1974), Barro (1974), Darby (1979), Calvo, Kotlikoff and Rodriguez (1977), Atkinson (1971), and Oulton (1976).

[6] Our methodological approach was greatly influenced by, and is similar to, Michael Darby's (1979) study which uses micro data in dividing total assets into life cycle and intergenerational transfer components. Our approach was also influenced by Brittain's (1978) study of wealth inequality.

[7] White (1978), p. 547. Indeed, White's estimates of life cycle savings may be substantially upward biased, because she does not take into account the existence of the unfunded social security system during the period for which savings is being simulated. Kotlikoff (1979) 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%. If White had considered the unfunded social security system, her life cycle model would have predicted substantially less accumulation and savings than she reported. Tobin (1967) uses a simulation analysis similar to White's and concludes, "it seems quite possible that life cycle saving can account for the U.S. capital stock."

Tobin's results, however, appear to reflect unrealistic assumptions about lifetime growth rates of consumption.

[8] Darby (1979), p. 3. 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 cohorts over age 65. 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 found Darby's methodology very instructive, we do not consider his findings conclusive evidence; the analysis relies heavily on information contained in the older tail of the age wealth distribution whose sample sizes are presumably quite small. In addition, the household, rather than the individual, is the unit of observation; the heads of households change over time due to mortality, this changes the position of households within the age wealth distribution. Treating the households as if it were an individual seems conceptually difficult.

[9] Mirer (1979), p. 442.

[10] Ibid.

[11] Darby (1979), pp. 22-28.

[12] Oulton (1976), p. 99.

[13] By examining (8) one can see that T corresponds simply to the accumulated holdings of transfers received by people who are currently alive from people who are currently dead. Transfers to and from individuals who are currently alive cancel in the formula. Darby's procedure in the steady state involves using the lifetime budget constraint to re-express (3) as the sum of two

wealth figures, one of which is used to finance future intergenerational transfers, the other of which is used to finance future consumption less earnings. Our procedure and Darby's yield the same number for transfer wealth when n=r. If r exceeds n, part of lifetime consumption is financed by interest earned on received transfers, and Darby's method will yield a smaller transfer component of wealths than will ours. The opposite holds true when n is less than r. Our economic appraisal of the importance of intergenerational transfers to capital formation is the same whether we use our own or Darby's accounting procedure.

[14] Boskin's (1978) estimate of transfer wealth appears to be based on this type of formula.

[15] In the case of a small, open economy in which interestand wage rates are pegged from abroad, the partial equilibrium and general equilibrium changes are identical. However, Feldstein and Horioka (1979) argue from an analysis of international saving and investment that domestic capital stocks are largely determined by domestic savings. This finding is, on the other hand, consistent with a world of completely mobile international capital in which U.S. factor returns are internationally determined; the Rybezynski theorem of international trade states that the international placement of capital does not determine international factor returns.

[16] Kotlikoff (1979) presents partial and general equilibrium responses in capital intensity to an unfunded social security system using a simulated life cycle model. He demonstrates that general equilibrium changes in capital intensity can be substantially smaller than partial equilibrium changes.

[17] $\frac{\partial S}{\partial T}$ equals zero because wage rates are held constant in this partial equilibrium analysis.

[17b] In the case of a tax on transfers the income effect of a change in transfers when $r = n$ will be zero only for the case of a compensated tax on transfers. Compensated, rather than uncompensated tax changes are the appropriate focus of studies of government tax policies towards savings. See Diamond (1970) and Kotlikoff and Summers (1979).

[18] The utility function in (13) corresponds only to that part of total utility pertaining to consumption and leisure. Any set of preferences for transfers may be added to (13) as long as they do not influence the relative choices of consumption and leisure at different points in time, i.e., as long as utility of consumption and leisure is separable from the utility of transfers. The assumption of a steady state with productivity growth also requires that the entire utility function be homothetic.

[19] Historical Statistics of the United States, Part 1, p. 8, and U.S. Statistical Abstract, 1978, p.

[20] Long Term Economic Growth, series A167 and A168, p. 210, and Manpower Report of the President, 1975, p. 336. We use Kendrix's series of output per man-hour for the years 1900-1910, and the BLS series thereafter.

[21] To obtain a real net rate of return series we subtract the annual percentage change in the CPI from our net nominal return series indicated in Table B2 Historical Statistics, Part I, pp. 210-211 and 1978 U.S. Statistical Abstract, p. 490.

[22] We also preformed these calculations for the more general iso-elastic utility function of the form:

$$U = \int_0^D \frac{C_t^{1-\gamma}}{1-\gamma} e^{-\rho t} \, dt + \alpha \int_0^D \frac{\ell_t^{1-\gamma}}{1-\gamma} e^{-\rho t} \, dt.$$

The term γ is the elasticity of the marginal utility of consumption and leisure. When γ equals one this utility function is logarithmic. We tried a wide range of parameter values for γ and ρ and found that for a 1 percent excess of r over n the values of $(1 - \frac{\partial M}{\partial T} - \frac{\partial C}{\partial T})$ ranged from .6 to .75. While it is unclear what utility function is most appropriate, these parameter values cover a wide range of different shapes of consumption and leisure profiles and, we presume, bound the likely response.

The assumption implicit in these utility functions

that consumption and leisure respond homothetically to changes in transfers may be inappropriate. In particular, even if the utility function is homothetic in consumption and leisure, the consumption and leisure response to a reduction in transfers may not be homothetic. This could arise because of capital market constraints precluding borrowing when young against future earnings. These capital market constraints may not be binding in the presence of transfers because the excess of consumption over earnings when young is financed by the received transfers. Eliminating or reducing transfers could make these capital market constraints binding and require proportionately less consumption and leisure when young than when old.

A third issue is the extent to which the U.S. economy can be sensibly characterized as moving along a steady state growth path. To the extent that underlying behavioral relations such as preferences for transferring wealth have changed in recent years, our calculation of transfer wealth may over or understate future levels of transfer wealth, although our calculated number will accurately describe historic levels of transfer wealth.

[23] Treating consumption of children under age 18 as their own life cycle consumption would greatly reduce our estimate of life cycle wealth and greatly increase our estimate of transfer wealth. The age at which we take adulthood to begin is somewhat arbitrary, but we feel that age 18 is a reasonable number and of general interest.

[24] Assets of children under age 18 are assumed to be completely inherited and thus are not included in life cycle wealth.

[25] In the actual calculation we use the formula:

$$W_{t+1} = W_t(1+r_t) + (1+.5\ r_t)(H_t+G_t-Z_t)$$

The .5 r_t factor allows for the receipt of interest on new savings which occurs smoothly throughout the year.

[26] See Bureau of the Census, "Estimates of the Population of the United States, 1900 to 1959." Population data after 1959 was obtained from the RAND Corporation. Prior to 1940 all individuals age 75 and over were jointly enumerated. After 1940 all individuals 85 and over are jointly enumerated. In carrying out the calculations involved in equation (14) and (17) we add over ages only up to age 75 for all years prior to 1941 and up

to age 85 for years after 1941. For the pre-1941 years we take the population of age 75 individuals to include all individuals 75 years old and older. After 1941 the population number for age 85 includes all people 85 and older.

[27] Figures for 1973 and 1974 come from <u>1977 Statistical Supplement to the Survey of Current Business</u>, p. 6. The figures for 1929 through 1970 come from <u>The National Income and Product Accounts of the United States, 1929-74</u>, (henceforth NIA), p. 36 and p. 329.

[28] See Kuznets, <u>National Income and Its Composition</u>, 1919-1938, pp. 322-323, Leven, et. al., <u>America's Capacity to Consume</u>, p. 155, and Kendrick's series A6 and B61 in <u>Long Term Economic Growth</u>, pp. 182, 222. Because of limitations on population estimates on individuals above age 85, we treat all individuals who were above age 85 in 1974 as if they were age 85. Since 85 year olds in 1974 did not reach the age 18 until 1907, we really don't use any data for the years prior to 1907 in this paper. We include our estimates of certain data series back to 1900 for possible use by other researchers.

[29] The number of self employed for the years 1966 through 1974 is available in the <u>U.S. Statistical Abstracts</u> for the years 1966-1975. For the years 1929 through 1965 the number of self employed is obtained by subtracting the number of full time equivalent employees (NIA, 1965, p. 102) from the number of persons engaged in production (NIA, 1965, p. 110). For 1919-1928 we use Kuznet's (1941, p. 340) estimates. King (1930, p. 162) presents a series for the total number of entrepreneurs for the years 1909-1927. For the years in which Kuznet's and King's series overlap, Kuznet's series averages 95.4% of King's. For the years 1907-1918 we, therefore,

reduce King's series by 4.6%. Budd (1960, p. 392) estimates the number of entrepreneurs in 1900. We assume a smooth 1.4% growth in the number of entrepreneurs from 1900 to 1909, the first year of King's series. Average earnings of full time employees is given in NIA (1974), p. 210 for 1929 through 1974 and in Historical Statistics, p. 164 series D724 for 1900 through 1928.

[30] Christensen (1971), p. 577.

[31] We obtained a time series on personal income taxes from the IRS Statistics of Income, using various issues from 1913 through 1974. State income taxes are reported in NIA (1974), pp. 108-109, p. 341 for the years after 1928. Historical Statistics, Part II, p. 1126 gives state income taxes for the years 1922 and 1927. We assume a smooth growth in taxes to fill in the years, 1923 to 1926, and 1928. Prior to 1922 state income taxes are zero. Federal and state income taxes are apportioned yearly to labor income according to the yearly share of wages, salaries, and proprietor's income in gross income. See Statistics of Income.

[32] Contributions for disability insurance as well as disability benefits are excluded from our calculation because they essentially cancel in our computation.

[33] U.S. Social Security Administration, Annual Statistical Supplement, p. 75. There appears to be no comparable data detailing average earnings by age and sex for as many years as this social security data on median earnings. By comparing median with average cross sectional age earnings profiles for 1971 (see Annual Earnings and Employment Patterns of Private Nonagricultural Employees, 1971 and 1972, pp. 100, 114, 226, 240) we found that the median curve slightly underestimates relative average earnings prior to age 21.

To adjust for this, we assumed constant relative earnings between ages 18 and 21 in all of our calculations. This adjustment is somewhat greater than necessary and biases our results towards more life cycle savings.

The estimated age earnings regression coefficients (standard errors) are:

	Constant	Age	Age^2	Age^3	Age^4	Age^5	Age^6
Males	21.096	-2.406	.170	-.590E-2	.108E-3	-.010	.375
	(2.199)	(.136)	(.009)	(.298E-3)	(.530E-5)	(.481E-3)	(.175E-4)
Females	4.964	.329	.243E-2	-.808E-3	(.263E-4)	-.336E-2	.154E-3
	(3.264)	(.203)	(.013)	(.444E-3)	(.789E-5)	(.715E-3)	(.260E-4)

	Year	Year^2	Year^3	Year x Age^2	Year x Age^3	Year^2 x Age	R^2
Males	-.373	.576E-2	-.307E-4	-.110E-4	-.100E-7	.728E-5	.984
	(.099)	(.158E-2)	(.838E-5)	(.713E-5)	(.5E-7)	(.234E-5)	
Females	-.419	.662E-2	-.353E-4	.731E-5	-.160E-6	.217E-5	.832
	(.147)	(.234E-2)	(.124E-4)	(.106E-4)	(.800E-7)	(.348E-5)	

[34] The year 1955 was chosen because by 1955 the social security data covers most of the private economy's work force.

[35] From the social security median earnings data we calculated the female-male ratio of median earnings at age 40. In 1937 this ratio took on its highest value .462. After 1950 the ratio never exceeds .410 and averages .381. 1971 and 1972 BLS data (<u>Annual Earnings and Employment Patterns</u>) indicate that ratios of average earnings at age 40 are very close to ratios of median earnings at age 40. The 1971 female-male ratio of average earnings at 40 was .402; in 1972 it was .395. The 1939 Census does, however, report a much higher ratio. The female-male ratio of median earnings for the age group 35 to 44 equaled .539 (<u>U.S. Census 1940</u>, "Wage or Salary Income in 1939," Table 6, p. 99). Commerce Department data for 1945 and 1946 indicates ratios

of median earnings of .462 and .508 for the two years respectively. (Current Population Reports, P-60, No. 1, p. 19 and No. 3, p. 20.)

[36] Employment and Training Report of the President, 1978, p. 256.

[37] The BLS labor force participation rates that we used in the work experience rate regression were obtained from the Employment and Training Report of the President, 1978, p. 183. The regression coefficients (standard errors) are given below. LFP stands for labor force participation rate.

	Constant	Age	Age^2	Age^3	Age^4
Males	399.573 (185.020)	-106.313 (37.937)	9.699 (2.991)	-.340 (.101)	.582 E-2 (.166 E-2)
Females	-507.558 (77.258)	87.467 (13.371)	-5.340 (.875)	.163 (.029)	-.273 E-2 (.545 E-3)

	Age^5	Age^6	LFP	LFP^2	LFP^3
Males	-.502 (.136)	.176 E-1 (.457 E-2)	448.285 (257.504)	1569.597 (350.406)	-1638.062 (372.664)
Females	.241 (.053)	-.883 E-2 (.206 E-2)	.110 (.015)	238.063 (89.662)	327.804 (169.139)

	LFP^4	AgexLFP	Age^{2}xLFP	AgexLFP^2	Age^{3}xLFP
Males	735.217 (176.068)	-90.796 (33.082)	1.911 (.807)	-3.312 (2.126)	-.011 (.550 E-2)
Females	-421.672 (139.757)	-10.000 (3.198)	.566 (.136)	-8.213 (1.436)	-.581 E-2 (.130 E-2)

Male $R^2 = .987$ Female $R^2 = .992$

[38] A labor force participation regression was estimated for males using pooled Census data for 1890, 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 1910, 1920, and 1930 Census data. This function was used to impute female

Footnote 38 (continued)

Males

Year(s)	Constant	Age	Age^2	Age^3	Age^4	Age^5	R^2
1890, 1900 1910, 1920	-352.122	50.082	-2.119	.426 E-1	.405 E-3	.144 E-5	.965
	(50.220)	(8.439)	(.517)	(.145 E-1)	(.189 E-3)	(.920 E-6)	
1930	-362.913	47.239	-1.879	.365 E-1	-.344 E-3	.124 E-5	.963
	(88.025)	(13.434)	(.738)	(.185 E-1)	(.215 E-3)	(.930 E-6)	
1940	-739.442	99.216	-4.522	.988 E-1	-.104 E-2	(.415 E-5)	.986
	(29.683)	(4.119)	(.211)	(.502 E-2)	(.564 E-4)	(.240 E-6)	
1950	-577.426	78.451	-3.556	.779 E-1	-.821 E-3	.331 E-5	.987
	(26.375)	(3.660)	(.187)	(.446 E-2)	(.501 E-4)	(.210 E-6)	
1960	-688.866	95.117	-4.461	.101	-.109 E-2	.454 E-5	.982
	(35.921)	(4.984)	(.255)	(.608 E-2)	(.682 E-4)	(.290 E-6)	
1970	-746.515	101.639	-4.765	.108	-.118 E-2	.489 E-5	.989
	(38.829)	(5.105)	(.250)	(.578 E-2)	(.631 E-4)	(.260 E-6)	

Females

Year(s)	Constant	Age	Age^2	Age^3	Age^4	Age^5	R^2
1910, 1920 1930	-273.604	40.916	-1.982	.440 E-1	-.459 E-3	.182 E-5	.819
	(39.687)	(6.176)	(.346)	(.887 E-2)	(.105 E-3)	(.470 E-6)	
1940	-434.611	60.481	-2.869	.635 E-1	-.667 E-3	.268 E-5	.904
	(38.411)	(5.330)	(.273)	(.650 E-2)	(.729 E-4)	(.310 E-6)	
1950	-449.243	64.908	-3.219	.746 E-1	-.816 E-3	.339 E-5	.854
	(205.897)	(28.884)	(1.491)	(.357 E-1)	(.401 E-3)	(.170 E-5)	
1960	-442.441	66.076	-3.358	.780 E-1	-.897 E-3	.379 E-5	.900
	(155.123)	(22.265)	(1.167)	(.282 E-1)	(.317 E-3)	(.134 E-5)	
1970	-384.109	59.309	-3.028	.727 E-1	-.822 E-3	.351 E-5	.953
	(195.483)	(26.457)	(1.321)	(.307 E-1)	(.336 E-3)	(.139 E-5)	

participation rates up to 1935. In addition, separate regressions for each of the years 1930, 1940, 1950, 1960, and 1970 were run for males using Census data. For females separate 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 ajacent regression. We pooled the early years because of the paucity of Census age categories for those years. We selected the years to be pooled on the basis of an examination of raw data. The coefficients (standard errors) from these regressions are given below.

[39] Distributions of social security and median benefits by age and sex were com from data in the social security <u>Annual Statistical Supplements</u> for the years 1953, 1958, 1963, 1968, and 1973. The distributions for the closest adjacent year were used to allocate benefits for the post-1937 years not indicated. The distributions take into account all types of social security benefits, i.e., retiree, dependent, widow, etc. Total flows of benefits are found in the 1975 supplement, Table 53.

[40] State and federal transfer payments other than social security and Medicare can be found in the NIA, pp. 128, 341, for the years after 1929. Our transfer figures include unemployment insurance, railroad retirement benefits, veteran benefits, as well as all types of welfare payments. For the years from 1900 to 1928 we estimated government transfers as one quarter of total government expenditure (see <u>Historical Statistics</u>, II, p. 1114). We chose this ratio after an examination of the ratio of transfers to total expenditures during the 1930's.

[41] <u>NIA</u>, pp. 79, 335. 1977 <u>Business Statistics</u>, p. 9, <u>Long Term Economic Growth</u>, Series A23, p. 184, and Series B64, p. 222.

[42] Christensen and Jorgenson's "true" consumption series which appears in <u>U.S. Income, Savings, and Wealth</u>, p. 17 is very close to the NIA series for the years 1929 to 1969. The Christensen and Jorgenson series is slightly higher for most years; using the Christensen and Jorgenson series for the post-1929 years would, therefore, lead us to calculate less life cycle wealth.

[43] The 1960 CES reports the age and sex of the head, the sex of the spouse, the number of children under 18, the number of adults over age 65, and the number of other family members between 18 and 65.

[44] We actually performed this calculation separately for the years 1972 and 1973 and then pooled the yearly averages after adjusting for the percentage increase in overall average consumption between 1972 and 1973. In computing total household consumption we imputed the rental value of privately owned homes by multiplying the value of the house by 6 percent. New purchases of automobiles was counted as consumption, and no rent was imputed for automobiles which were previously acquired.

[45] The coefficients (standard errors) for the 1972-1973 CES relative consumption profiles are:

	Constant	Age	Age^2	Age^3
Males	2.273 (1.960)	-.415 (.308)	.298 E-1 .193 E-1)	-.933 E-3 (.615 E-3)
Females	-1.000 (2.103)	.655 E-1 (.330)	.262 E-2 (.207 E-2)	-.140 E-3 (.660 E-3)

	Age^2	Age^5	Age^6	R^2
Males	.148 E-1 (.106 E-1)	-.118 E-2 (.943 E-3)	.377 E-4 (.337 E-4)	.978
Females	.209 E-2 (.114 E-1)	-.119 E-3 (.101 E-2)	.173 E-5 (.362 E-4)	.978

[46] From the 1972-73 tape we calculated the average age and the percentage male of other household members under the age of 65 by the age of the head. We then assigned other family members who appear in the 1960 CES an age and a sex according to the age of the household head.

[47] We have been unable to locate the 1950 CES tape which represents the only other major study of consumption during this century.

[48] The 1960 profiles indicate less relative consumption when young which, by itself, means more life cycle accumulation. However, they also exhibit less relative consumption when old, which, by itself leads to less life cycle wealth. These two elements appear roughly to cancel.

[49] In the table below we compare Federal Reserve data points of relative consumption by age with the 1972-73 CES relative consumption profiles.

	Males		Females	
Age	CES	Federal Reserve	CES	Federal Reserve
21	.489	.487	.592	.653
27	.711	.679	.866	.794
32	.909	.659	.996	.980
37	.991	.838	1.046	.926
42	1.010	1.163	1.031	1.074
47	.971	.842	.969	.854
52	.910	.768	.879	.780
57	.834	.706	.779	.788
62	.751	.598	.682	.685
67	.660	.571	.594	.540
72	.560	.411	.510	.429

All profiles peak around age 40. The Federal Reserve profiles exhibit less relative consumption at older ages than do the CES profiles.

[50] See Goldsmith, *Studies in the National Balance Sheet of the United States*, vol. II, pp. 118, 126, 130, 72-83. Goldsmith's data extends to 1958. Smith (1974, p. 174) presented an updated Goldsmith-type balance sheet for 1968, which we employ.

[51] Manhattan Island Real Estate Mortgage Rates: Roy Wenzlick Research Corp., reported in *Long Term Economic Growth*, series B77, p. 224.

[52] *Historical Statistics*, p. 1004.

[53] *Ibid*.

[54] *Ibid*., p. 1004.

[55] NIA, pp. 264, 349.

[56] Goldsmith, *op. cit*., vol. I, pp. 170-171

[57] The imputed rent series is the sum of net interest plus rental income of persons, NIA (1974), pp. 304-305. The value of residential houses and land is available from the Federal Reserve-MIT household sector balance sheets from 1947 to the present.

[58] Total IRS (*Statistics of Income*) income taxes for each year are divided by total income for each year.

[59] Evans (1969), Table 2.3, p. 37. Munnell provided us with her series, and F Modigliani, David Modest, and Doug Battenberg sent us the latest FRB-MIT wealth data. In applying equation (22) we use Evans numbers for the years 1929-1941, and 1946-1950, Munnell's numbers for 1942-1945, and the FRB-MIT series after 1950. To insure that differences in the absolute level of these series did not affect our computed interest rate, we always used the same wealth series for the terms W_t and W_{t-1}.

[60] See the FRB-MIT balance sheets.

[61] SEC Statistical Bulletin, June 1977, p. 11.

[62] Ibid. This assumes that non-profit institutions have no liabilities.

[63] From the 1972-73 CES tape we calculated the average age gap between husband and wife to be three years. The number of deaths in an age sex cohort in a particular year were obtained by multiplying age, sex, and year specific death rates from the Census Bureau's population estimates. We smoothed the <u>Historical Statistics</u>, vol. I, death rates, series B 181-192, pp. 61-62.

Even in the absence of marriage, our LCWII concept would be of interest because it essentially treats individuals as if their wealth at each moment was fully annuitized; i.e., given the uncertainty of the date of death, individuals in a life cucle model with no bequest motive would always purchase annuities. Hence, our procedure of essentially passing a cohort's bequest over to surviving members mimics the operation of an annuitities market. LCWII can then be thought of as essentially the life cycle wealth of the U.S. economy if individuals always purchased annuities.

[64] These include increasing the labor income of the self-employed by 20 percent, using a high value of .55 for the ratio of female to male earnings at age 40, assuming that the age consumption profile is flat after age 75, and assuming that all earnings after age 75 are zero.

[64b] Roger Gordon has suggested to us that observed age earnings profiles may differ from true age earnings profiles to the extent that firms and workers are engaged in implicit contractual arrangements. Firms could pay out to workers less (more) thanthey truly earn when young and more (less) than they truly earn when old. Some part of a worker's life cycle saving or dissaving would then be accomplished within th firm and would correspond to a claim (or liability) attached to the firm's assets. While we would strongly contest the empirical validity of this proposition, certainly very upper bound estimate of life cycle savings with firms would be the difference between the market and replacement costs of capital in the corporate sector. Using .819, the average value of q

over the period 1952-1974 (von Furstenberg, 1977) and the 1974 replacement value of corporate capital of 1.679 trillion dollars gives an upper bound estimate of $304 billion for this effect.

[65] In 1970 for example the level of philanthropic payments of individuals totaled 16.09 billion (Historical Statistics, vol. I., series H 399-400, p. 359). In comparison, the NIA (1974 p. 90, lines 101 and 102) reported 1970 expenditures of institutions for religious, educational and welfare activities totaled only $11.32 billion.

[66] If we take age 18 as the age of adulthood, the value of 55 for D corresponds to a real world age of death of 73.

[67] To precisely calculate a weighted age gap we would need data detailing age of donors and recipients as well as the size of the transfers. Such data is currently unavailable.

[68] Historical Statistics, vol. I, series B181-192, pp. 61-62. In generating this distribution we divided the wealth of married households evenly between the two spouses.

[69] 1978 Statistical Abstract, p. 138.

[70] Joseph Froomkin, Testimony to the Committee on Ways and Means, p. 479.

[71] 1978 Statistical Abstract, p. 165.

[72] Statistics of Income, Fiduciary Income Tax Returns for 1970, p. 46.

Appendix A: Calculation of Partial Equilibrium Responses of Accumulated Consumption and the Accumulated Value of Leisure for the Logrithmic Utility Function

To simplify the exposition we assume that transfers are received at age I only and that they are given at age G only. In the steady state b is the transfer received at age I; $be^{n(G-I)}$ is therefore the transfer made at age G that is needed to maintain transfers per person (or per effective worker when there is productivity growth) constant. Letting P_o be the population of age zero individuals, accumulated transfer wealth T is given by:

$$T = \int_I^D b\ e^{r(a-I)}\ P_o\ e^{-na}\ da - \int_G^D b\ e^{n(G-I)}\ e^{r(a-G)}\ P_o\ e^{-na}\ da \tag{a1}$$

In (a1) aggregate T reflects transfers received less transfers made accumulated up to the present at rate r and added up over the population. This equation simplifies to:

$$T = P_o\ b\ \frac{e^{(r-n)D}}{r-n}\ e^{-rI}(1-e^{(n-r)(G-I)}) \tag{a2}$$

Note that in the case $r=n$, $T=bP_I(G-I)$; i.e., T equals the age gap (G-I) times the flow of transfers, bP_I. This is the same (r=n) formula that we derived for the three period example in the text, viz., equation (9).

The lifetime budget constraint may be written as:

$$\int_o^D C_t\ \ e^{-rt}\ dt + \int_o^D m_t\ e^{-rt}\ dt = S^* + be^{-rI}(1-e^{(n-r)(G-I)}) \tag{a3}$$

Again, the terms C_t and m_t are the values of expenditures on consumption and leisure at time t. The m_t's can be written as ℓ_t times W_t, the number of units of leisure times the value of a unit of leisure at time t. S* is the present value of full time earnings and $be^{-rI}(1-e^{(n-r)(G-I)})$ equals the present value excess of transfers received over transfers made during the lifetime. Note that when r=n this term equals zero, exactly as in equation (12'). By maximizing the utility function (13) subject to (a3) we obtain:

$$(a4) \qquad (m_t + C_t) = \frac{\rho}{(1-e^{-\rho D})} \; e^{(r-\rho)t} \; (S^* + be^{-rI} \; (1-e^{(n-r)(G-I)}))$$

Now accumulated consumption plus the accumulated value of leisure can be expressed as:

$$(a5) \qquad M + C = \int_o^D (\int_o^a \; (m_t+C_t) \; e^{r(a-t)} dt) \; P_o \; e^{-na} \; da$$

Equations (a4) and (a5) imply:

$$(a6) \qquad M + C = \frac{P_o(S^*+be^{-rI} \; (1-e^{(n-r)(G-I)})}{(1-e^{-\rho D})} \; (\frac{e^{(r-n)D}-1}{r-n} - \frac{e^{(r-\rho-n)D}-1}{r-\rho-n})$$

From (a6) and (a2) we obtain:

$$(a7) \qquad M + C = \frac{P_o S^*}{1-e^{-\rho D}} \; (\frac{e^{(r-n)D}-1}{r-n} - \frac{(e^{(r-\rho-n)D}-1)}{r-\rho-n})$$

$$+ \frac{T(r-n)}{e^{(r-n)D}(1-e^{-\rho D})} (\frac{e^{(r-n)D}-1}{r-n} - \frac{(e^{(r-\rho-n)D}-1)}{r-\rho-n})$$

Hence, we derive:

$$(a8) \qquad \frac{\partial (M+C)}{\partial T} = \frac{r-n}{e^{(r-n)D}(1-e^{-\rho D})} \; (\frac{(e^{(r-n)D}-1)}{r-n} - \frac{(e^{(r-\rho-n)D}-1)}{r-\rho-n})$$

Appendix B: Data Series

Table B1

Year	Employee Compensation (In Billions)	Labor Income of the Self Employed (In Billions)	Net Nominal (percentage) Series I	Interest Rates Series II
1900	8.771	3.465	9.075	
01	9.769	3.681	10.832	
02	10.176	4.023	-.664	
03	10.821	4.122	12.116	
04	10.749	4.223	12.212	
05	11.830	4.353	.392	
06	13.651	4.540	-10.725	
07	14.397	4.831	28.263	
08	12.932	4.806	12.367	
09	15.090	5.117	.653	
10	16.266	5.420	4.606	
11	16.498	5.546	6.474	
12	17.587	5.690	-.493	
13	18.822	6.007	-1.485	
14	18.516	6.080	18.314	
15	19.361	6.053	8.513	
16	22.470	6.730	-6.987	
17	25.802	7.692	11.902	
18	32.324	9.288	13.351	
19	37.139	10.705	-3.627	
20	43.890	12.616	6.052	
21	35.536	11.540	14.620	
22	37.003	11.254	3.806	
23	43.339	12.100	13.567	
24	43.323	12.369	13.669	
25	45.019	12.727	4.229	
26	48.017	13.005	7.682	
27	48.433	13.380	21.335	
28	49.361	13.504	22.628	
29	51.088	14.737	-4.497	-2.102
30	46.835	14.332	-13.986	-11.936
31	39.741	13.426	-21.827	-15.457
32	31.054	11.809	-1.463	-3.109
33	29.538	11.066	28.947	7.697
34	34.293	11.626	3.001	5.240
35	37.334	12.295	21.927	9.211
36	42.902	12.691	18.122	5.078
37	47.921	13.381	-11.612	-3.905
38	44.983	12.891	13.588	4.371
39	48.094	13.140	2.868	9.165

Table B1 (continued)

Year	Employee Compensation (In Billions)	Labor Income of the Self Employed (In Billions)	Net Nominal (percentage) Series I	Interest Rates Series II
1940	52.110	13.347	.908	8.457
41	64.774	14.844	.730	2.287
42	85.257	17.148	8.861	13.239
43	109.543	18.541	9.058	6.870
44	121.211	19.687	6.880	11.472
45	123.092	20.614	14.618	8.158
46	118.052	23.593	4.580	11.303
47	129.174	26.640	4.536	11.795
48	141.440	28.774	3.469	5.783
49	141.318	29.040	7.170	6.700
50	154.844	30.470	11.303	11.186
51	181.000	31.984	6.599	3.490
52	195.698	33.739	6.109	4.649
53	209.570	35.054	1.736	3.470
54	208.397	35.495	18.275	4.942
55	224.907	36.707	12.314	10.004
56	243.513	38.104	3.390	5.701
57	256.481	39.048	-.622	4.267
58	258.245	39.747	13.913	3.309
59	279.579	41.058	4.581	16.752
60	294.932	42.145	2.818	4.260
61	303.568	43.184	10.050	8.625
62	325.098	44.311	-.018	1.593
63	342.882	45.156	8.592	9.634
64	367.957	47.396	7.355	8.538
65	396.543	49.029	5.975	7.663
66	439.290	50.024	.229	.114
67	471.915	45.221	8.450	11.143
68	519.815	47.802	6.871	12.406
69	571.354	51.530	-.723	3.164
70	609.150	54.199	7.873	5.716
71	650.271	57.959	8.813	8.350
72	715.145	62.380	9.824	13.960
73	799.200	66.979	1.485	7.589
74	875.800	73.830	-1.402	3.197

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