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AN ANALYSIS OF POSTWAR CONSUMPTION AND SAVING: PART II
Empirical Results

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Working Paper No. 2606

Erratum

This is a revised version of Working Paper No. 2606, "An Analysis of U.S. Postwar Consumption and Saving: Part II - Empirical Results" by Michael J. Boskin and Lawrence J. Lau. Some of the results were incorrectly placed at the end of Working Paper No. 2605, "An Analysis of Postwar U.S. Consumption and Saving: Part I - the Model and Aggregation" by Boskin and Lau. For the reader's convenience, we have reprinted this corrected version.

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ABSTRACT

A new empirical analysis of aggregate United States consumption and saving for the period 1947-80 is presented. The model is based on the theory of exact aggregation. It recognizes explicitly that households with different characteristics may be heterogeneous in their behavior and that aggregate behavior may depend on the changing composition of households by characteristics and therefore may not be adequately portrayed by a representative consumer, but otherwise it imposes minimal assumptions on household behavior. The model integrates longitudinal and cross-sectional microeconomic data on household characteristics with the traditional aggregate time-series data. Various hypotheses on consumption, such as age independence, proportionality to wealth, and price independence, are tested and rejected. Strong evidence of relative price effects and a systematic variation of aggregate consumption with changing age distribution of wealth in the economy is found. Especially important is the substantial estimated difference in the shares of wealth consumed between households headed by persons born prior to and those born after 1939. One important lesson from this study is that modeling the aggregate U.S. economy as a representative consumer may give rise to misleading results.

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4.3 Estimation Results

The results of the conditional maximum likelihood estimation are presented in Tables 4.1 and 4.2. The statistical fit is good as is also graphically apparent from Figures 4.5 and 4.6. The (conditional) asymptotic standard errors of the estimators of the parameters are not unduly large; and the Durbin-Watson statistics appear acceptable. In Figure 4.7 we present the aggregate residuals (the difference between actual and predicted aggregate consumption or leisure expenditures) as a percentage of actual aggregate consumption or leisure expenditures. On a percentage basis, the aggregate residual never exceeds 3 percent of the actual value.

The first order of business is to test whether our specification of the age profile effects (which imposes fixed differences among the consumption expenditure-wealth and leisure expenditure-wealth ratios of different age-cohorts in in 1972) is better than a flat age profile (that is, no age effects other than the vintage 1939 effect) in explaining the data. Since there is no change in the degrees of freedom, we simply compare the logarithms of the likelihood under each of the two specifications. These are reported in Table 4.3, and it is apparent that the imposed age profile is preferred to the flat age file.

Continuing our analysis but now maintaining the imposed age profile, we proceed to test the five hypotheses outlined in Section 3.5 by the likelihood ratio method. Asymptotically, minus 2 times the difference in the logarithm of the likelihood ratio is distributed as the χ^2 distribution under the null hypothesis. The test statistics are presented in Table 4.4. For the convenience of the readers we provide the critical values of the test statistics at the 1 and 5 percent levels of significance in Table 4.5.

It is apparent from Tables 4.4 and 4.5 that with the exception of intertemporal separability, all the hypotheses can be rejected at the 1 percent level of significance. However, the hypothesis of separability of the current period consumption and leisure from those of the future periods, often a maintained hypothesis in tests of other hypotheses concerning aggregate consumption (e.g., Boskin and Kotlikoff (1985) and their test of intergenerational altruism, and Hall and Mishkin (1982) and Bernanke (1984) and their tests for the importance of liquidity constraints),[30] cannot be rejected at the 5 percent level of significance.

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30. We should add, however, that our concept of intertemporal separability is more general than the usual one because we do not assume the existence of a utility function for the household as a whole, let alone its maximization. The hypothesis that is tested is a necessary condition for the household utility function to be intertemporally separable if it exists.

Table 4.1
Estimated Consumption Expenditure Function

Parameter	Base Case
α_c	0.1736 (1.1220)
α_{c14}	-0.0366 (-5.3792)
α_{c25}	-0.0307 (-7.4284)
α_{c35}	-0.0072 (-1.9149)
α_{c55}	0.0070 (0.9363)
α_{c65}	0.0188 (0.9222)
β_{cc}	0.0081 (1.0567)
β_{cz}	0.0026 (0.1670)
β_{cr}	0.1324 (0.6853)
γ_{cf}	0.0256 (1.2316)
γ_{cu}	-0.0015 (-3.0830)
γ_{cv}	-0.0165 (-5.3503)
β_c	-0.2105 (-1.4548)
β_r	-3.3700 (-2.4042)
Standard Error	0.0004
Durb.-Wat. Stat.	1.60
Mean of Dependent Variable	0.0377
Log of Likelihood	438.892

* Asymptotic t-ratios in parentheses.

Table 4.2
Estimated Leisure Expenditure Function

Parameter	Base Case
α_z	0.1404 (2.9702)
α_{z14}	-0.0108 (-7.6460)
α_{z25}	-0.0028 (-1.7421)
α_{z35}	-0.0028 (-2.5277)
α_{z55}	0.0418 (12.194)
α_{z65}	-0.0420 (-6.4138)
β_{zc}	-0.0102 (-2.3195)
β_{zz}	0.0186 (4.6935)
β_{zr}	0.0834 (1.1049)
γ_{zf}	-0.0032 (-3.3392)
γ_{zu}	0.0018 (5.3877)
γ_{zv}	0.0012 (2.2965)
β_c	-0.2105 (-1.4548)
β_r	-3.3700 (-2.4042)
Standard Error	0.0004
Durb.-Wat.Stat.	1.69
Mean of Dependent Variable	0.0316
Log of Likelihood	438.892

*Asymptotic t-ratios in parentheses.

Figure 4.5

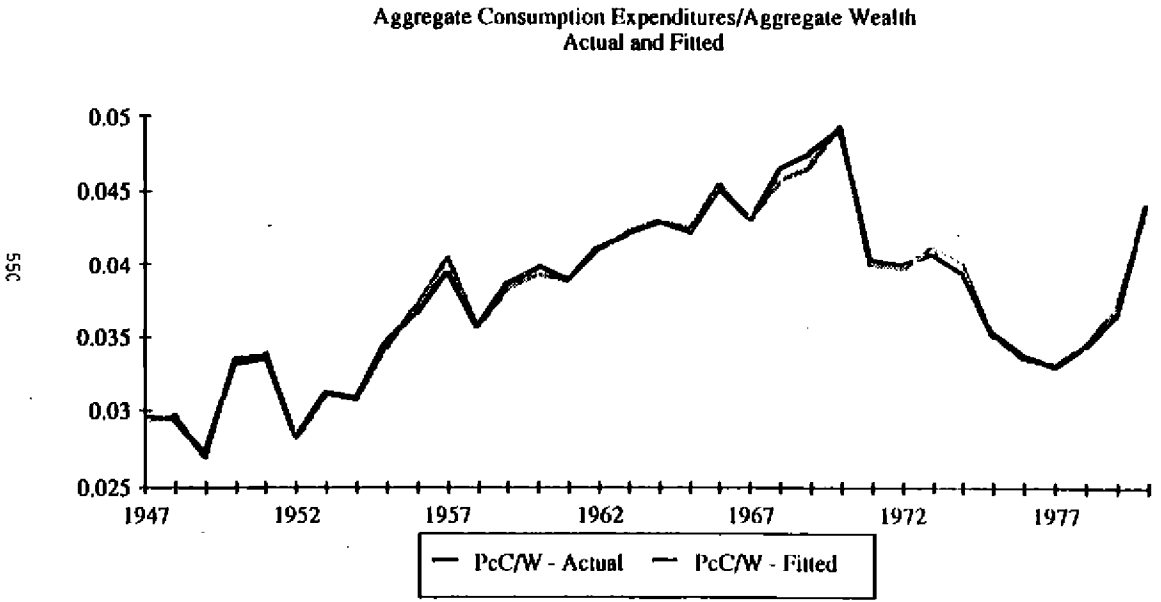
Aggregate Consumption Expenditures/Aggregate Wealth
Actual and Fitted
0.05
0.045
0.04
0.035
0.03
0.025
1947
1952
1957
1962
1967
1972
1977
PcC/W - Actual
PcC/W - Fitted

Figure 4.6

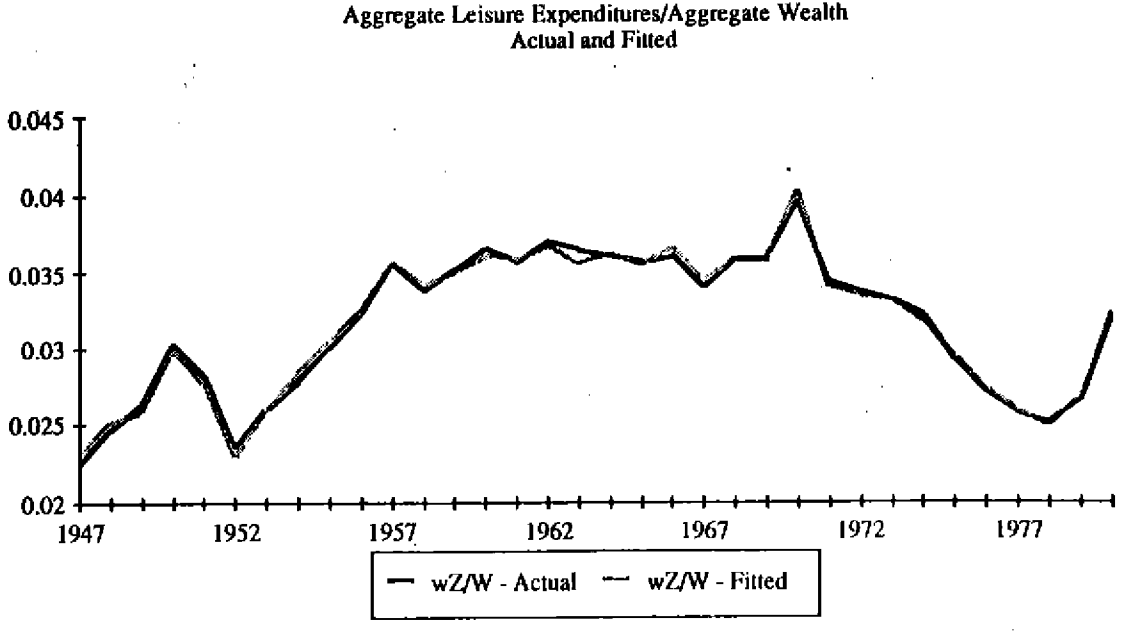
Aggregate Leisure Expenditures/Aggregate Wealth
Actual and Fitted
0.045
0.04
0.035
0.03
0.025
0.02
1947
1952
1957
1962
1967
1972
1977
wZ/W - Actual
wZ/W - Fitted

Figure 4.7

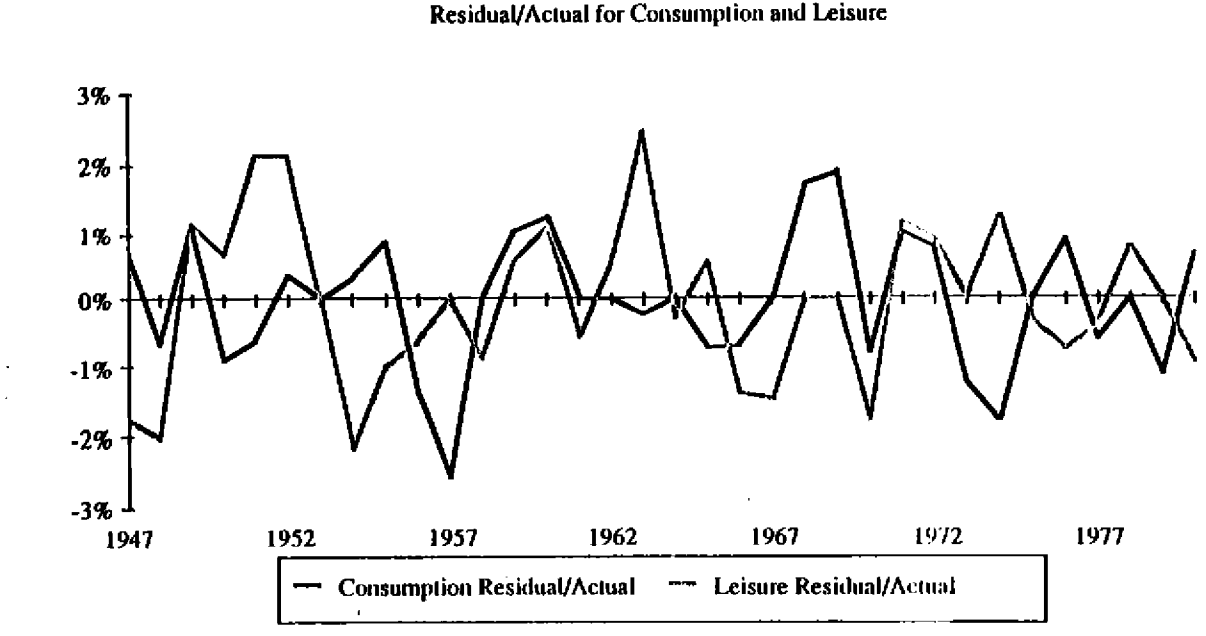
Residual/Actual for Consumption and Leisure
3%
2%
1%
0%
-1%
-2%
-3%
1947
1952
1957
1962
1967
1972
1977
Consumption Residual/Actual
Leisure Residual/Actual

Table 4.3

Test of Imposed Age Profile
vs
Flat Age Profile

Model	Log Likelihood
Imposed Age Profile	438.9
Flat Age Profile	435.3

Table 4.4

Log Likelihoods of Alternative Models

Model	Log Likelihood	-2 x Change in Log Likelihood from Basic Specification	Change in Degrees of Freedom from Basic Specification
Basic Specification	438.9	0	0
Unitary Wealth Elasticity	431.1	15.6	2
Proportionality	424.5	28.8	5
Intertemporal Separability	437.3	3.2	2
Absence of Interest Rate Effects	405.7	66.4	3
Complete Price Independence	322.2	233.4	9

Table 4.5

Critical Values of χ^2 Distribution

Degrees of Freedom	Levels of Significance 1%	5%
2	9.210	5.991
3	11.341	7.815
5	15.086	11.070
9	21.666	16.919

4.4 Interpretations

For the consumption expenditure function, the profile of estimated age-cohort coefficients rises monotonically.[31] The female labor force participation rate does not have a statistically significant effect. The coefficient for the unemployment rate has the expected negative sign and is statistically significant. The share of wealth held by households headed by persons born prior to 1939 has a statistically significant and negative effect. For every one percentage point increase in the share of wealth held by this group of households, the aggregate consumption-wealth ratio declines by 1.65 percentage points. In other words, if wealth were to be held entirely by this group, or if all other groups behaved similarly to this group, the consumption-wealth ratio would have been lower by 1.65 percentage points, a very significant amount![32]

The real rate of interest also has a statistically significant effect: an increase in the real rate of interest, holding human and nonhuman wealth and hence, total wealth, constant, increases the consumption expenditure.

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31. Recall that the dependent variable is the ratio of aggregate consumption to wealth, and that human wealth, and hence total wealth, declines rapidly for the last two age cohorts.

An increase in the real after-tax rate of interest lowers the forward prices of future consumption, under our assumptions, relative to the spot price of current consumption. The net effect is, however, theoretically ambiguous. Here we find that it is positive. Correspondingly, its effect on saving (as defined in the National Income and Product Accounts) is negative. The net effect of a change in the real after-tax rate of return depends upon the relative sizes of these effects. The negative of the sum of the coefficients β_{cc} and β_{cz} measures the effect of a change in the size distribution of wealth on aggregate consumption. It is found to be negative, so that an increase in the degree of inequality of the size distribution of wealth holding average real wealth constant decreases aggregate consumption. We discuss the calculation of the net effect and its implication for consumption and saving later in this section.

For the leisure expenditure function, the profile of estimated age-cohort coefficients takes a hump-shape: it rises monotonically until the cohort 45-54 and then declines.[33] The female labor force participation rate has a statistically significant and negative effect on leisure expenditure, as expected. The coefficient for the unemployment rate has the expected positive sign and is statistically significant. The share of wealth held by

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32. Note that we do not interact the age cohort and vintage effects; instead, we estimate a uniform average vintage effect. It is possible that the vintage effect may be larger at some ages than at others. Indeed, one of the key questions in the future evolution of U.S. private saving is whether the post-Depression vintage will "break out" of their lower age-saving profile.

households headed by persons born prior to 1939 has a statistically positive and significant effect. The effect, however, is small. The price of consumption and the wage rate both have statistically significant effects on leisure: however, the precise direction of the effect depends on the values of the parameters as well as the variables as they work in the same direction on the numerator and the denominator. The real rate of interest also has a statistically significant effect similar to that on consumption expenditure. The negative of the sum of the coefficients, β_{zc} and β_{zz}, measures the effect of a change in the size distribution of wealth on aggregate leisure. It is found to be slightly positive, so that an increase in the degree of inequality of the size distribution of wealth holding average real wealth constant increases aggregate leisure.

In Table 4.6, we present first estimates of the elasticities of consumption, leisure, total expenditure and saving of a representative household headed by a person in the 45-54 age cohort in 1972 with respect to total, human, and nonhuman wealth, the price of consumption, wage rate and the real after-tax rate of interest, holding both human and nonhuman wealth constant, calculated from the formulae derived in Section 3.7. These estimates are labelled "without human wealth revaluation". However, in

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33. We note that the unimodality constraint on α_{z25} is effective.

Table 4.6

Estimated Elasticities for Consumption, Leisure, Total Expenditure, and Saving
with respect to
Wealth, Interest Rate, Wage Rate, and Price

(Calculated for households headed by persons in age cohort 45-54
with the independent variables evaluated at their 1972 values.)

WITHOUT HUMAN WEALTH REVALUATION

Elasticity	CONSUMPTION		LEISURE		TOTAL EXPENDITURE		SAVING	
with respect to	Pre-1939	Post-1939	Pre-1939	Post-1939	Pre-1939	Post-1939	Pre-1939	Post-1939
Total Wealth	0.747 (2.785)	0.775 (3.253)	0.799 (9.199)	0.818 (10.354)	0.773 (4.825)	0.796 (5.530)	-8.867 (-4.2177)	-10.349 (-4.923)
Human Wealth	0.671 (2.785)	0.696 (3.253)	0.718 (9.199)	0.734 (10.354)	0.694 (4.825)	0.714 (5.530)	-9.106 (-4.825)	-10.437 (-5.530)
Non-Human Wealth	0.076 (2.785)	0.079 (3.253)	0.082 (9.199)	0.084 (10.354)	0.079 (4.825)	0.081 (5.530)	0.239 (1.113)	0.088 (0.407)
Real Interest Rate	0.250 (2.023)	0.238 (2.236)	0.209 (6.898)	0.203 (7.211)	0.230 (3.304)	0.220 (3.694)	-2.423 (-2.655)	-2.623 (-3.014)
Wage Rate	-0.178 (-0.615)	-0.185 (-0.730)	-0.796 (-7.742)	-0.837 (-7.853)	0.012 (0.076)	-0.014 (-0.096)	3.512 (1.826)	3.764 (1.987)
Price of Consumption	-0.568 (-8.217)	-0.590 (-9.298)	-0.003 (-0.036)	0.019 (0.216)	0.215 (3.603)	0.218 (3.372)	-3.222 (-3.603)	-3.628 (-3.372)

WITH HUMAN WEALTH REVALUATION

Elasticity	CONSUMPTION		LEISURE		TOTAL EXPENDITURE		SAVING	
with respect to	Pre-1939	Post-1939	Pre-1939	Post-1939	Pre-1939	Post-1939	Pre-1939	Post-1939
Real Interest Rate	0.069 (1.131)	0.049 (0.990)	0.015 (1.177)	0.004 (0.034)	0.042 (1.285)	0.027 (1.045)	0.041 (0.095)	0.197 (0.518)
Wage Rate	0.492 (6.197)	0.510 (7.235)	0.921 (11.320)	0.897 (10.246)	0.706 (12.125)	0.701 (11.167)	-5.994 (-7.590)	-6.673 (-9.002)

Asymptotic t-ratios in parentheses.

reality, when the real after-tax rate of interest changes, wealth can be expected to remain constant only if it is held entirely in the form of floating-rate assets (and liabilities). In general, if the stream of future incomes remains the same, wealth is expected to decrease with an increase in the real after-tax rate of interest. In this study, we assume that nonhuman wealth is held entirely in the form of floating-rate assets and thus is insensitive to changes in the real rate of interest, but not human wealth. We therefore also present the same elasticities with respect to the real rate of interest and the wage rate "with human wealth revaluation".

We find that the elasticities of consumption, leisure and total expenditure with respect to total wealth fall approximately between 0.75 and 0.80. The elasticity of saving with respect to total wealth is, however, large, negative, and statistically significant. The elasticities of consumption, leisure and total expenditure with respect to human wealth are all somewhat smaller than the corresponding elasticities with respect to total wealth, in fact, by the same proportionality factor. The elasticity of saving with respect to human wealth is also large and negative. The elasticities of consumption, leisure and total expenditure with respect to nonhuman wealth are statistically significant but less than 0.1 in magnitude. Translated to the more usual marginal propensities to consume out of nonhuman wealth, the estimates are about .025, similar to, but perhaps slightly smaller than, the usual time series estimates. The elasticity of saving with respect to nonhuman wealth is positive but not statistically significant. The elasticity of consumption with respect to the price of consumption is negative as expected and statistically significant at about -0.6. The elasticity of leisure with respect to the price of consumption is negligible and statistically insignificant. The elasticity of total expenditure with respect to the price of consumption is relatively

small (approximately 0.2) but statistically significant. The elasticity of saving with respect to the price of consumption is large (approximately -3.5) and statistically significant.

Holding both human and nonhuman, and hence total, wealth constant, the elasticities of consumption, leisure and total expenditure with respect to the real after-tax rate of interest lie between 0.20 and 0.25 and are statistically significant. The elasticity of saving with respect to the real rate of interest is approximately -2.5 and statistically significant. This finding of a large negative elasticity of saving with respect to the real rate of interest may seem surprising but is dependent on the hypothesis that wealth is held constant, a hypothesis we relax below. The elasticity of consumption with respect to wage rate is negative but not statistically significant although it is suggestive of possible complementarity between current consumption and current leisure. The elasticity of leisure with respect to the wage rate is negative as expected and statistically significant. The elasticity of total expenditure with respect to wage rate is negligible and statistically insignificant. The elasticity of saving with respect to the wage rate is positive and large and on the border line of being statistically significant.

With full human wealth revaluation, however, the comparative static effects of increases in the real after-tax rate of interest and the wage rate change considerably. The elasticities of consumption, leisure, total expenditure and saving with respect to the real after-tax rate of interest all become negligible or statistically insignificant or both. The elasticities of consumption, leisure and total expenditure with respect to the wage rate are positive, between zero and one, and statistically significant. The elasticity of saving with respect to the wage rate turns

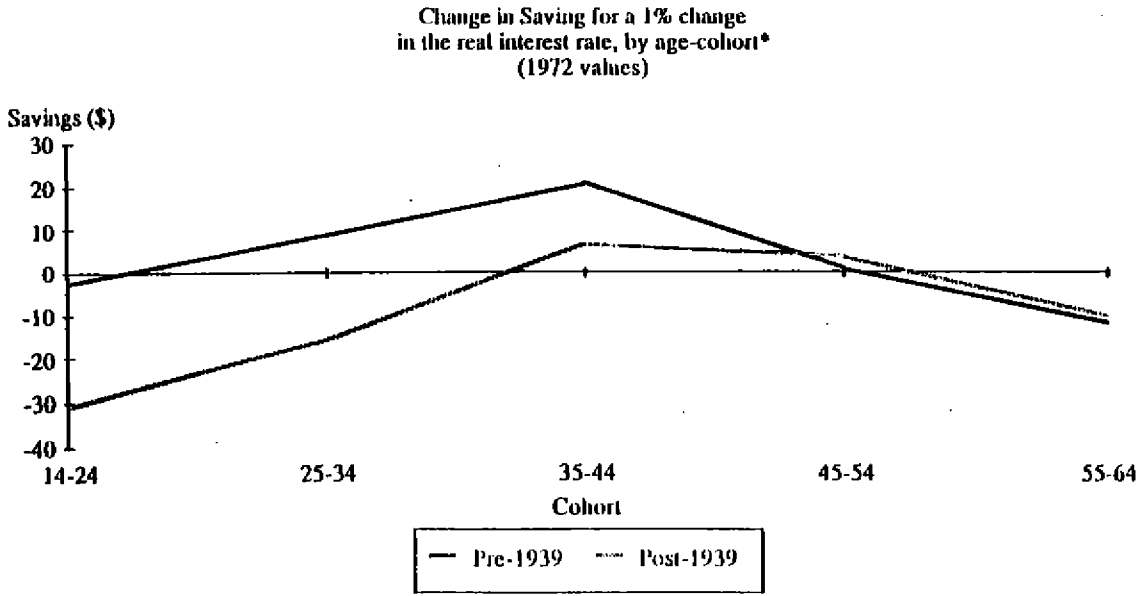
negative and large and is statistically significant. The finding that with full human wealth revaluation, the elasticity of saving with respect to the real after-tax rate of interest is statistically not different from zero may also seem surprising in view of the results of some other aggregate time-series consumption function studies, e.g., Boskin (1978) and Summers (1982, 1984).

We should note that the elasticities presented in Table 4.6 are for a household headed by a person in the 45-54 cohort with the independent variables set equal to their 1972 values and therefore are not directly comparable to other studies. We present estimates of elasticities of aggregate saving below.

The estimated comparative static effects differ quite systematically between the pre-1939 and post-1939 vintages of households and also differ across different age cohorts and households with different ratios of nonhuman to total wealth. In Figure 4.8, we show how the effects on saving, with full human wealth revaluation, of a one percent change in the real after-tax rate of interest in 1972, differ between pre and post-Depression vintages and across age cohorts. In Figure 4.9, we show how the effects on saving, with full human wealth revaluation, of a one percent change in the real interest rate in 1972, differ across households headed by persons in the 45-54 age cohort with different ratios of nonhuman to total wealth. Note, in particular, that the effects turn from negative to positive as the ratio of nonhuman to total wealth exceeds approximately ten percent.

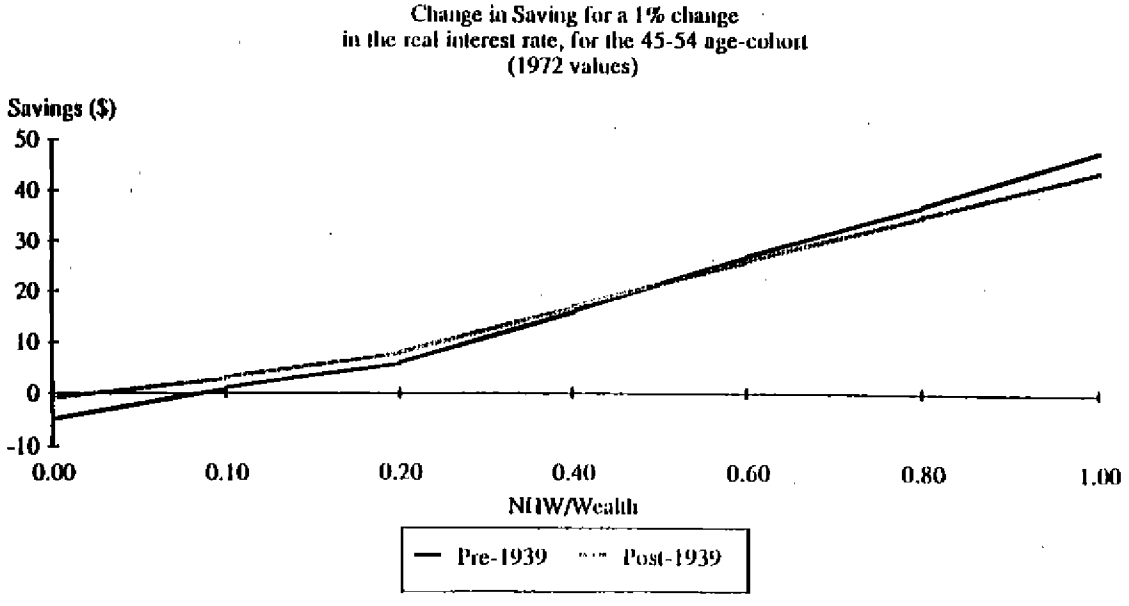
It is of some interest to calculate the interest elasticity of aggreate saving, taking into account the joint distribution of households by wealth, pre and post-Depression vintage, age cohort, and the ratio of nonhuman to total wealth. This parameter represents the percentage change in aggregate saving in response to a one-percent change in the real after-tax rate of

Figure 4.8



*Evaluated at Mean Level of NHW for each cohort. Real Interest Rate in 1972 was 3.7%.

Figure 4.9



The ratio of NHW to Wealth in 1972 was 0.102. The real interest rate in 1972 was 3.7%.

interest. This elasticity is calculated to be -0.5376 without human wealth revaluation and -0.0046 with human wealth revaluation in 1972. The corresponding numbers for 1980 are 0.4911 and 0.1137. Thus, it is apparent that in the aggregate, with full human wealth revaluation, the interest elasticity of saving is quite small within the prevailing ranges of values of the independent variables.

4.5 Comparison to Previous Research

The results reported here are not directly comparable to previous research because of differences in the specification and measurement of the model and the variables, especially the estimation of aggregate consumption and leisure in terms of their shares of wealth. In this Section we provide the translation necessary to compare our results to the usual consumption function estimates.

First, the results strongly reject the notion that a "representative consumer" model can adequately explain aggregate consumption behavior in the postwar United States. In particular, demographic factors, especially the age composition of the population and the age distribution of aggregate resources, appear to be important determinants of aggregate consumption. While not a formal test of either lifecycle theory or the intergenerational altruistic model of aggregate consumption, the results do suggest that the age distribution of resources is important, (and hence that the strong form of Ricardian equivalence does not hold in the aggregate U.S. time series), and that at least some form of consumption smoothing by age relative to income by age is occurring.

The value of the interest elasticity of saving, once one defines the relevant experiment as was done in Section 4.4, has been the subject of a tremendous controversy (see, for example, Howrey and Hymans (1980)) because of its implication for the effects of fiscal policy, structural tax policy,

and the social rate of discount, to name but a few. The results reported here are somewhat different from the results of Boskin (1978) and Summers (1981, 1982, 1984) concerning the effects of the real after-tax rate of return on aggregate saving. The estimated aggregate interest elasticities range from -.5 to 0.5, depending on whether we use 1972 or 1980 values of the independent variables and whether we revalue human wealth. This heterogeneity is also noted in Summers (1982). As discussed in section 3.7, revaluing human wealth always increases the interest elasticity of saving for a household with positive saving and decreases it for a household with negative saving. With some households saving and others dissaving, the aggregate effect, being a weighted average, is in general indeterminate.

The results reported here also lend support to the notion that taxation of saving can affect aggregate saving, although obviously the effects must net the effect on savers against the effect on dissavers. The effect on saving of its reduced taxation will be positive (and eventually large) only for those households with nonhuman wealth exceeding 10 percent of their total wealth. For those with little nonhuman wealth the effect will be negative.

The wealth elasticity and the implied marginal propensity to consume out of wealth are similar to those reported in the typical consumption studies (see for example, Boskin (1987) and other studies discussed in Bernheim (1987)), about 0.75 and 0.025 respectively for households headed by the 45-54 year old cohort in 1972.

It is not our purpose here to compare our results to each and every time series study of aggregate consumption in the United States component by component. It is somewhat reassuring that the merging of aggregate with disaggregated data and other potential improvements we have made lead to

estimates which are comparable with previous research. Perhaps the most important finding concerns the apparent tremendous difference in the propensity to save by households headed by persons born pre and post 1939, at the same age. It appears that as the share of total national resources held by persons born post 1939 rises, the national saving rate will decrease unless some major modifications occur in the consumption/wealth patterns at later ages for persons born post 1939, or some of the other variables affecting consumption change substantially.

5. Accounting for the Growth in Consumption in the United States, 1950-1980

5.1 Decomposition of Growth in Consumption

We have constructed a model of aggregate consumption which appears to explain the U.S. postwar consumption data quite well. We have also found interesting and significant demographic effects on aggregate consumption, ranging from those of the age distribution of wealth, to differential saving patterns for households headed by persons born pre- and post-1939. The female labor force participation rate and other variables also affected aggregate consumption. Importantly, relative prices, including the real after-tax rate of interest, on average appear to have a substantial effect on aggregate consumption.

Aggregate consumption grew substantially in the United States in the three and a half decades following World War II and we attempt to account for this growth on the basis of our model. We divide the thirty-year period into two sub-periods: 1950-62 and 1963-80. Recall from Figure 4.1 that the growth of aggregate consumption expenditure accelerated around this break point. In fact, as Table 5.1 reveals, the annual percentage change in real aggregate consumption was 2.74% in the 1950-62 period but accelerated

to 3.45% in the 1963-80, an increase of about 25%.[34]

We combine our estimated consumption expenditure share function with information on the changes over the relevant sample subperiod in the variables affecting aggregate consumption shares to "explain" the growth in annual aggregate real consumption, i.e., to decompose the change in aggregate real consumption into components corresponding to its proximate determinants. Specifically, by observing that the systematic part of the right-hand side of equation (4.1) must be homogeneous of degree zero in p_t, w_{0t} and W_{it} (under the no money illusion assumption), we may rewrite equation (4.1) as:

$$(5.1)\quad \sum_i p_t C_{it} \;/\; \sum_i W_{it}$$

$$= \left[\alpha_c+\beta_{cz}\ell n(w_{0t}/p_t) + \beta_{cr}\ell n(1+r_t) - (\beta_{cc}+\beta_{cz})\left(\sum_i (W_{it}/p_t)\ell n(W_{it}/p_t) \;/\; \sum_i (W_{it}/p_t)\right)\right.$$

$$+ \sum_j \alpha_{cj} \left(\sum_i D^j_{it}(W_{it}/p_t) \;/\; \sum_i (W_{it}/p_t)\right) + \gamma_{cf}\,\mathrm{FLPR} + \gamma_{cu}\,\mathrm{UE}$$

$$\left. + \gamma_{cv} \sum_i D^{39}_{it}(W_{it}/p_t) \;/\; \sum_i (W_{it}/p_t)\right] \;/\; \left[1 - \beta_c \ell n(w_{ot}/p_t) + \beta_r \ell n(1+r_t)\right]$$

Equation (5.1) may be further transformed into:

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34. We confine our analysis to the period 1950-80, as Figures 4.2 and 4.3 reveal unusual swings in consumption and saving rates the first few years after World War II.

$$(5.2)\quad \sum_i C_{it} = N_t \cdot \left\{ \sum_i C_{it}/N_t \right\}$$

$$- N_t \cdot \left\{ \left(\sum_i p_t C_{it} \;/\; \sum_i W_{it} \right) \left(\sum_i (W_{it}/p_t) \;/\; N_t \right) \right\}$$

$$- N_t \left\{ \left(\sum_i (W_{it}/p_t)/N_t \right) \left[\alpha_c + \beta_{cz} \ell n(w_{0t}/p_t) + \beta_{cr} \ell n(1+r_t) \right.\right.$$

$$- (\beta_{cc}+\beta_{cz}) \left(\sum_i (W_{it}/p_t) \; \ell n(W_{it}/p_t) \;/\; \sum_i (W_{it}/p_t) \right)$$

$$+ \sum_j \alpha_{cj} \left(\sum_i D_{it}^j W_{it} \;/\; \sum_i W_{it} \right) + \gamma_{cf} \, FLPR + \gamma_{cu} UE$$

$$\left.\left. + \gamma_{cv} \left(\sum_i D_{it}^{39} W_{it} \;/\; \sum_i W_{it} \right) \right] \Big/ \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t) \right] \right\}.$$

Thus, the rate of change of aggregate real consumption may first be decomposed into the sum of the rates of change of real consumption per household and the rate of change of the number of households. The rate of change of real consumption per household may be further decomposed into the sum of the effects of the changes of real wealth per household, the real wage rate, the real after-tax rate of interest, the distribution of real wealth by size, age cohort and vintage, the female labor force participation rate and the unemployment rate. The effect of the change in the distribution of wealth by age cohort may be further decomposed into the sum of two effects: the effect of a change in the age composition of households alone and the effect of a change in the relative wealth across age cohorts.

We note that the size distribution of real wealth variable may be rewritten as:

$$\left[\sum_i (W_{it}/p_t)\ \ell n\ (W_{it}/p_t)/\sum_i (W_{it}/p_t)\right]$$

$$- \left[\sum_i (W_{it}/p_t)\ \ell n\ (W_{it}/p_t)/\sum_i (W_{it}/p_t) - \ell n\left(\sum_i (W_{it}/p_t)/N_t\right)\right] + \ln\left(\sum_i (W_{it}/p_t)/N_t\right)$$

$$- \left[\sum_i W_{it}\ell nW_{it}/\sum_i W_{it} - \ell n\left(\sum_i W_{it}/N_t\right)\right] + \ell n\left(\sum_i (W_{it}/p_t)/N_t\right)$$

with the term in the square brackets invariant with respect to a proportional change of all W_{it}'s and hence to a change in the average real wealth per household. Using this decomposition of the size distribution of wealth variable, equation (5.2) may be rewritten as:

$$(5.3)\quad \ell n\left(\sum_i C_{it}/N_t\right) - \ell n\left(\sum_i (W_{it}/p_t)/N_t\right)$$

$$+ \ell n\Bigg\{\Bigg[\alpha_c + \beta_{cz}\ell n(w_{0t}/p_t) + \beta_{cr}\ell n(1+r_t)$$

$$- (\beta_{cc} + \beta_{cz})\left[\left[\sum_i W_{it}\ell nW_{it}/\sum_i W_{it} - \ell n\left(\sum_i W_{it}/N_t\right)\right]\right.$$

$$\left. + \ell n\left(\sum_i (W_{it}/p_t)/N_t\right)\right] + \sum_j \alpha_{cj}\left[\sum_i D^j_{it}\ W_{it}/\sum_i W_{it}\right]$$

$$+ \gamma_{cf}\ \text{FLPR} + \gamma_{cu}\text{UE} + \gamma_{cv}\left[\sum_i D^{39}_{it}\ W_{it}/\sum_i W_{it}\right]\Bigg]/$$

$$\left[1 - \beta_c \ell n(W_{0t}/p_t) + \beta_r \ell n(1+r_t)\right]\Bigg\}$$

The effect of a change in the real wealth per household on the change in real consumption per household may be computed as:[35]

$$(5.4)\quad (\partial \ell n(\sum_i C_{it}/N_t)) \;/\; (\partial \ell n(\sum_i (W_{it}/p_t)/N_t))$$

$$= 1 - \left[(\beta_{cc}+\beta_{cz}) \;/\; (\sum_i p_t C_{it}/\sum_i W_{it})\right] \;/\; \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right]$$

The change in the real consumption per household, net of the change in real wealth per household, may be decomposed using the following formulae:

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35. Bear in mind that $\left[\sum_i W_{it} \ell n W_{it}/\sum_i W_{it} - \ell n\left(\sum_i W_{it}/N_t\right)\right]$ is invariant with respect to a proportional change of all W_{it}'s and hence in general is invariant with respect to a change in the average real wealth per household.

(5.5) $$\left(\partial \ell n\left(\sum_i C_{it}/N_t\right) \,/\, \left(\partial \ell n(w_{0t}/p_t)\right)\right) \Big|_{\text{average real wealth constant}}$$

$$= \left[\left(\beta_{cz} \,/\, \left(\sum_i p_t C_{it} \,/\, \sum_i W_{it}\right)\right) + \beta_c \right] \,/\, \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

(5.6) $$\partial \ell n\left(\sum_i C_{it}/N_t\right) \,/\, \partial \ell n r_t \Big|_{\text{average real wealth constant}}$$

$$= \left[\left(\beta_{cr}/\left(\sum_i p_t C_{it} \,/\, \sum_i W_{it}\right)\right) - \beta_r\right] \frac{r_t}{(1+r_t)} \,/\, \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

(5.7) $$\frac{\partial \ell n\left(\sum_i C_{it}/N_t\right)}{\partial\left(\sum_i W_{it} \ell n W_{it} \,/\, \sum_i W_{it} - \ell n\left(\sum_i W_{it}/N_t\right)\right)} \Big|_{\text{average real wealth constant}}$$

$$= \left[-(\beta_{cc}+\beta_{cz})/\left(\sum_i p_t C_{it} \,/\, \sum_i W_{it}\right)\right] \,/\, \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

(5.8) $$\left(\partial \ell n\left(\sum_i C_{it}/N_t\right)\right) \,/\, \left(\partial\left(\sum_i D_{it}^j W_{it} \,/\, \sum_i W_{it}\right)\right)$$

$$= \left[(\alpha_{cj})/\left(\sum_i p_t C_{it} \,/\, \sum_i W_{it}\right)\right] \,/\, \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

$$(5.9)\quad (\partial \ell n(\sum_i C_{it}/N_t)) \;/\; (\partial(\sum_i D_{it}^{39} W_{it} / \sum_i W_{it})$$

$$= \left[(\gamma_{cv})/(\sum_i p_t C_{it} / \sum_i W_{it})\right] / \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

$$(5.10)\quad (\partial \ell n(\sum_i C_{it}/N_t))/\partial FLPR$$

$$= \left[(\gamma_{cf})/(\sum_i p_t C_{it}/\sum_i W_{it})\right] / \left[1-\beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right];$$

and

$$(5.11)\quad (\partial \ell n(\sum_i C_{it} / N_t))/\partial UE$$

$$= \left[(\gamma_{cu}) / (\sum_i p_t C_{it} / \sum_i W_{it})\right] / \left[1 - \beta_c \ell n(w_{0t}/p_t) + \beta_r \ell n(1+r_t)\right].$$

The effect of the change in the distribution of wealth by age cohort is obtained by adding up all the effects of changes in the shares of wealth held by each age-cohort as given in equation (5.8). This effect can be further decomposed into a pure age composition effect (which holds the average relative wealth per household of each age cohort constant) and a pure change in relative wealth effect (which holds the age composition of the households constant).

The results of the decomposition exercise are presented in Table 5.1.[36] The first thing to note about the data in Table 5.1 is that a large fraction of the acceleration in the average annual rate of growth of aggregate real consumption in the United States in the mid to late 1960s and 1970s was due to an increased rate of household formation. There was still an increase in the average real consumption per household; but the substantial increase in the number of households, due partly to population growth, changing living patterns, and rising life expectancies, accounts for almost half of the growth in aggregate real consumption in the period 1950-1962, and almost 65 percent in the period 1963-1980.

Turning next to the factors affecting average real consumption per household, we see that average real wealth per household declined very slightly in the first sub-period and resulted in a net decrease in consumption of between one and two-tenths of a percentage point, whereas in the latter sub-period, average real wealth increased substantially and accounted for about seven-tenths of a percentage point annual increase in real consumption.

We turn now to examine the two most important relative prices, real wage rates and real interest rates. Real wage rates rose rapidly over the whole period but about 40% more rapidly in the first sub-period than in the second. These trends account for the negative three-tenths and two-tenths of a percentage point effect of the growth in real consumption in the two sub-periods, respectively. Real interest rates rose slightly in the first

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36. Bear in mind that these results use the point estimates of the coefficients presented in Table 4.1.

TABLE 5.1

Decomposition of Annual Growth Rate of Aggregate Consumption

Period 1950-1962

Average Annual Percentage Δ in Real Consumption	2.74
Change due to Household Growth	1.30
Net Annual Percentage Δ in Real Consumption per Household	1.44

Variable (average annual change over sample)	Percentage Point Δ in Growth of Net Real Consumption due to:	As a % of Percentage Δ in Net Real Consumption
Without Human Wealth Revaluation		
Average Real Wealth (-0.21%)	-0.14	-9.7%
Real Wage Rate (1.63%)	-0.28	-19.4%
Real Interest Rate (0.12 percentage point)	1.00	69.4%
Size Distribution of Real Wealth	-0.40	-27.8%
Age Distribution of Wealth	0.23	16.0%
Depression Vintage-1939 (-0.51 percentage point)	0.28	19.4%
Female Labor Participation Rate (0.35 percentage point)	0.29	20.1%
Log of Prime Age White Male Unemployment Rate (-0.73 percentage point)	0.04	2.8%
Other	0.42	29.2%
With Human Wealth Revaluation		
Average Real Non-Human Wealth (-1.55%)	-0.13	-9.3%
Real Wage Rate	0.69	47.9%
Real Interest Rate	0.02	1.7%

Decomposition of Percentage Δ in Wealth	Due to		
Percentage Δ Wealth	NHW	HW - Interest Rate	HW - Wage
-0.21	-0.205	-1.464	1.460

TABLE 5.1 (continued)

Decomposition of Annual Growth Rate of Aggregate Consumption

Period 1963-1980

Average Annual Percentage Δ in Real Consumption	3.45
Change due to Household Growth	2.22
Net Annual Percentage Δ in Real Consumption per Household	1.23

Variable (average annual change over sample)	Percentage Point Δ in Growth of Net Real Consumption due to:	As a % of Percentage Δ in Net Real Consumption
Without Human Wealth Revaluation		
Average Real Wealth (0.97%)	0.66	53.7%
Real Wage Rate (0.88%)	-0.16	-13.0%
Real Interest Rate (-0.07 percentage point)	-0.50	-40.7%
Size Distribution of Real Wealth	0.16	13.0%
Age Distribution of Wealth	-0.71	-57.7%
Depression Vintage-1939 (-3.16 percentage point)	1.34	108.9%
Female Labor Participation Rate (0.72 percentage point)	0.48	39.0%
Log of Prime Age White Male Unemployment Rate (1.70 percentage point)	-0.07	-5.7%
Other	0.03	2.4%
With Human Wealth Revaluation		
Average Real Non-Human Wealth (-2.01%)	-0.16	-13.0%
Real Wage Rate	0.38	30.9%
Real Interest Rate	-0.22	-17.9%

Decomposition of Percentage Δ in Wealth	Due to		
Percentage Δ Wealth	NHW	HW - Interest Rate	HW - Wage
0.97	-0.235	0.411	0.794

Addendum to Table 5.1:

The effect of the **Age Distribution of Wealth** is merely the sum of the distribution effects for each cohort. Moreover, the cohort effect can be further decomposed into

(1) the **Age Composition of Households**, and
(2) the **Relative Household Wealth by Age**

1950-1962		Decomposed into	
Cohort	Age Distribution of Wealth	Age Composition of Households	Relative Household Wealth by Age
14-24	-0.0573	-0.0297	-0.0265
25-34	0.3095	0.3474	-0.0444
35-44	-0.0259	0.0109	-0.0376
45-54	----	----	----
55-64	0.0069	-0.0025	0.0095
65+	0.0015	0.0534	-0.0408
Total Effect	0.2348	0.3796	-0.1398

1963-1980		Decomposed into	
Cohort	Age Distribution of Wealth	Age Composition of Households	Relative Household Wealth by Age
14-24	-0.2748	-0.2738	-0.0007
25-34	-0.4500	-0.5227	0.0528
35-44	0.0642	0.0671	-0.0037
45-54	----	----	----
55-64	-0.0216	-0.0123	-0.0105
65+	-0.0320	0.0064	-0.0368
Total Effect	-0.7143	-0.7353	0.0012

sub-period but fell slightly in the second sub-period; they account for the positive one and then negative one-half percentage point of growth in real consumption in the two sub-periods, respectively. Indeed, except for the growth in the number of households in the first sub-period, the effect of changes in real interest rates was larger than that of any other factor, whereas in the second sub-period their effect was larger than any factor other than the growth in average real wealth and the Depression vintage effect.

We turn next to the variables reflecting the size and age distribution of wealth. During the first sub-period, the change in the size distribution of wealth, which had become more unequal, had a negative effect of four-tenths of a percentage point on the growth of real consumption, whereas the change in the age distribution of wealth accounted for about two-tenths of a percentage point of the growth of aggregate annual consumption, or 16% of the total. Further, the Depression vintage effect accounted for almost three-tenths of a percentage point of the growth in average real annual consumption as the share of wealth held by households headed by persons born after 1939 grew slowly over this period. It accounted for about one-fifth of the net percentage change in real consumption per household.

During the second sub-period, the size and age distribution of wealth and vintage effects were also large. The size distribution of wealth effect accounted for an almost two-tenths of a percentage point increase in the net percentage change in average annual real consumption, about 13% of the actual net increase. The age distribution of wealth effect subtracted another seven-tenths of a percentage point from what would otherwise have been the change in real consumption per household, more than 50% of the full change in absolute value. The Depression vintage effect became very large

in this period. The share of wealth held by persons born after 1939 rose much more rapidly in the second sub-period than in the first. Indeed, the Depression vintage effect alone, holding other variables constant, accounted for about a 1.3 percentage point increase in the annual rate of growth in consumption, more than 100% of the total.

The effects of changes in the age distribution of wealth can be further decomposed into two components: a pure age composition of households effect, which holds the average relative household wealth by age constant; and a pure relative household wealth by age effect, which holds the age composition of households constant. It turns out that the two components tended to work in opposite directions. For both sub-periods, the effects of changes in the age composition of households are responsible for the bulk of the effect of changes in the age distribution of wealth.

The above discussion of the effects of changes in the real wage rates and the real interest rates ignores the changes they may have caused in total real wealth through the revaluation of human wealth. If we include in their effects their indirect effects on real consumption through the revaluation of real human wealth, we find that the net effect of the real wage rate increases changes from -0.3% and -0.2% to 0.7% and 0.4% in the two sub-periods respectively, and the net effect of the changes in real interest rates correspondingly moves from 1.0% to virtually nil and from -0.5% to -0.2%.

These results suggest that the dramatic changes in the age distribution of income and wealth in the United States in the post-war period (documented more fully for the 1968-84 period by Boskin, Kotlikoff and Knetter (1985)) had substantial <u>net</u> impacts on the growth of aggregate consumption and saving. Indeed, the rapid shift of wealth toward post-Depression birth cohorts kept consumption growing rapidly despite increases in life

expectancy and the growth of income and wealth in the hands of retired persons (who by definition were born prior to 1939 in the period under study), i.e., the post-Depression generation's greater propensities to consume at young ages offset the movement of the pre-Depression generation into ages with greater propensities to save. Had the post-Depression birth cohorts shown similar consumption and saving patterns to the pre-1939 birth cohort, aggregate consumption would have increased substantially less and aggregate saving would have been quite a bit higher than in fact occurred.

The female labor force participation rate increased modestly in the first sub-period, and accounted for about three-tenths of a percentage point of the annual increase in average real consumption, whereas its rate of increase doubled in the second sub-period, and accounted for about a half of a percentage point of the annual increase in average real consumption.

Finally, we note that the business cycle effect, proxied by the logarithm of the prime age white male unemployment rate, despite its secular trend over the two sub-periods, had very little impact on average real consumption.

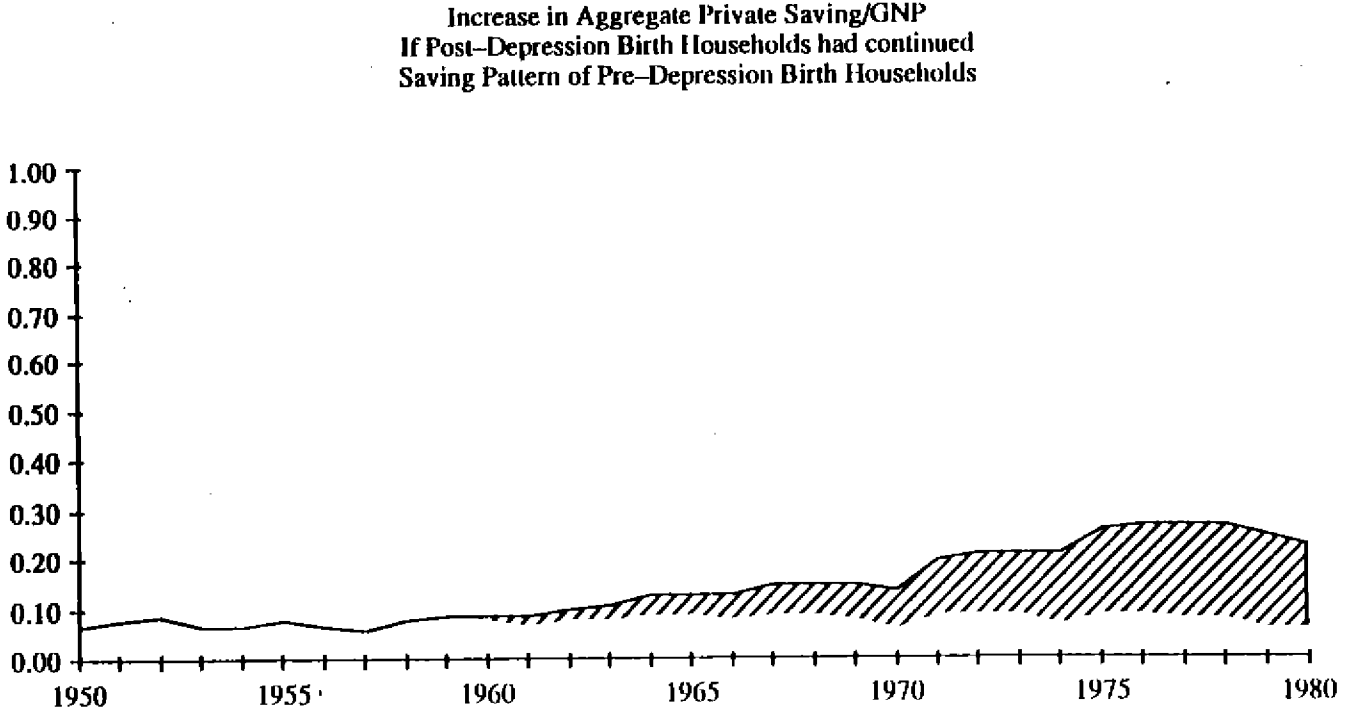
Taken as a whole, these results highlight how important various demographic trends have been in affecting aggregate consumption and its growth in the postwar United States. Aggregate consumption and saving are affected heavily by demographic patterns, although in the 1950-80 period and in the two sample subperiods, various demographic factors often offset one another. These demographic factors include the rate of household formation, the age composition of the population, the age distribution of wealth, the differences in the saving/consumption profiles over the lifecycle between persons born prior and subsequent to 1939, and the female labor force participation rate.

This decomposition, of course, is meant to examine the proximate determinants of the growth rate of consumption. We have not attempted to explain why there is an apparent difference in the consumption and saving rates at the same age of pre and post Depression birth cohorts or the acceleration of female labor force participation. One can develop numerous conjectures, not all of which are easily quantifiable. It is often mentioned anecdotally that persons who lived through the Depression are reluctant to borrow, whereas, again anecdotally, but buttressed by aggregate credit statistics, the growth of credit and borrowing for a wide range of purposes has become a part of life for persons born since the Depression. In turn, one might conjecture that part of this is due to the tax laws allowing deductibility of consumer interest payments with rising marginal tax rates in the period under study for the bulk of the population. It is not our purpose here to attempt to explain the facts we have uncovered, but we hope additional research will shed light on these issues. They appear to be quite important in assessing not only the economic history of the first few decades after World War II, but may well be important in determining the future evolution of consumption and saving patterns in the United States.

5.2 Importance of the Vintage Effect

The difference in saving propensities between households headed by persons of the pre- and post-1939 birth cohorts is not only large but has important implications for private, and hence, national saving. In Figure 5.1, we present the results of the hypothetical calculation of what total private saving would have been if the post-1939 generation had the same saving propensities, conditional on age and the other variables in our consumption expenditure function, as the pre-1939 generation. We compare

Figure 5.1


Increase in Aggregate Private Saving/GNP
If Post–Depression Birth Households had continued
Saving Pattern of Pre–Depression Birth Households
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1950
1955
1960
1965
1970
1975
1980

this hypothetical ratio of saving to GNP with our estimated saving/GNP ratio. The difference is substantial, averaging approximately 10% for the period 1963-80.

How important are these differences? First, the shaded area gives a very rough idea of the cumulative additional saving which would have occurred had the post-1939 generation saved "like their parents' generation".[37] This amounts to about 115% of 1980 GNP, or about 1/3 of the actual private nonhuman wealth. Even if we use an estimate of the cohort differential two standard errors smaller than our point estimate, the cumulative effect would have been more than 70% of 1980 GNP. Increases of cumulative savings of these magnitudes, if invested, would have increased GNP by about 7%-10% in the 1980s. Note that the share of wealth held by households headed by persons born post-1939 has been growing and therefore if the estimated differential saving propensities persist, private saving will continue to decline, ceteris paribus. Thus, the vintage effect is one explanation for the decline in the private saving rate from the average of 7.1% in the 1960s to the average of 5.8% in the 1980s.

To gain further perspective on the importance of this factor for the decline in private saving, consider that by 1980, the estimated annual decrease was almost equal to the actual private saving rate itself. Holding the government deficit and private domestic investment constant, reversing such a difference by itself would be more than sufficient to redress the imbalance in national saving and investment in the United States, eliminate

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37. The estimate is approximate both because increased saving leading to increased wealth would lead subsequently to increased consumption; and the increased saving may well have generated increased investment (not necessarily dollar for dollar in an open economy) and subsequently higher incomes.

the large current account deficit, and turn the U.S. into a net creditor nation.

6. Conclusion

We have developed and presented a new empirical analysis of aggregate United States consumption and saving for the period 1947-80. The research incorporates several novel features. The model is based on the theory of exact aggregation. It recognizes explicitly that households with different characteristics may be heterogeneous in their behavior and that aggregate behavior may depend on the changing distribution of households by characteristics and therefore may not be adequately portrayed by a representative consumer, but otherwise it imposes minimal assumptions on household behavior. We merge linked Current Population Survey data on the distribution of income and its components by the age of the head of the household and aggregate time series data on consumption, interest rates, etc. The econometric results are interesting and important. Using a general functional form, and imposing the budget constraint and "no money illusion", but not necessarily utility maximization, on the demand functions, and conditional on our assumptions on expectations, we generate estimates which track the actual consumption and saving in the economy quite well.

Restricting the functional form to impose various hypotheses on consumption prevalent in the literature such as age independence, proportionality, intertemporal separability, and price independence is instructive. We reject each of these hypotheses, with the exception of intertemporal separability. Most important are the overwhelming rejection of relative price independence and the rejection of age distribution of resources independence of aggregate consumption. We find strong evidence of

relative price effects, including interest rate effects, and a systematic variation of aggregate consumption with changes in the age distribution of wealth in the economy. Especially significant is the substantial estimated difference in the shares of wealth consumed between households headed by persons born before and after 1939. This vintage effect is so large that if the age-specific conditional saving rates of the post-Depression households were as large as those of the pre-Depression households, the private saving rate would have doubled its actual value in 1980. In essence, aggregate saving may be considered a weighted average of two vintages of household, pre- and post-Depression, each with its own specific age-saving profile, with the later vintage's profile lying below that of the earlier vintage. Since the share of aggregate income received and hence total wealth held by those in the later vintage is growing through time, a continuation of this phenomenon would suggest further erosion of the aggregate private saving rate.

Our results thus suggest that fiscal policies which affect the real after-tax rate of return (such as capital income taxes) and the age distribution of resources (such as the size of the public debt) might indeed have affected aggregate consumption in the period under study.

Our estimates of parameters such as the elasticity of consumption with respect to wealth and "the" interest elasticity of saving are also interesting. The former is quite consistent with those found in typical aggregate time series consumption functions which do not attempt to take into account the age distribution of resources, whereas the latter estimates shed some new light on the findings of Boskin (1978) and Summers (1981, 1982, 1984), who reported substantial elasticities. We present separate interest elasticities with and without the revaluation of human wealth and also demonstrate how the elasticity varies with the ratio of nonhuman to

total wealth. The results suggest that targeting tax incentives for saving at younger workers or those with few assets, i.e., those with low ratios of nonhuman to total wealth, is likely to lead to little effect on aggregate saving; the targeting, if any, should be on those with higher ratios of nonhuman to total wealth.[38] The recent IRA account limitations on deductability may thus be mistargeted on a "saving bang for the tax dollar loss buck" calculation.

An important lesson from our research is that modelling the U.S. economy as a representative consumer may be quite misleading. While this device may be useful for some analytical purposes, it is likely to leave out sufficiently important information so as to be potentially unreliable in analyzing aggregate data and/or policy experiments. This research lends strong support to efforts to model age-specific budget constraints and aggregate behavior, as is done in Auerbach and Kotlikoff (1983).

Our decomposition of the annual growth rate of aggregate consumption in the two sub-periods 1950-62 and 1963-80 into its proximate determinants revealed several important features. First, the acceleration in the rate of growth of aggregate consumption between the two sub-periods was due primarily to the increased rate of household formation. Second, by the latter sub-period the Depression vintage effect is the most important determinant of the rate of growth of consumption per household. Third, the net effect of interest rate changes with human wealth revalued is small.

Like all other research, our results have their advantages and

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38. Indeed, the survey information from the take-up rates for individual retirement accounts indicates that middle income households and households headed by persons in their 50's were the most likely to use IRAs.

limitations. It would be desirable to extend the analysis to include alternative specifications, for example, alternative specifications of expectations. It would also be desirable, as a test of specification of the model, to make conditional post-sample forecasts of the model. The major advantages of our approach are the flexibility of the specification of consumption expenditure functions, the minimal economic consistency requirements of "no money illusion" without any other strong maintained hypotheses such as utility maximization, let alone by a representative consumer. Another advantage is the integration of individual household and aggregate data and the tests of the hypotheses that the age distribution of resources affects aggregate consumption. We believe this research complements other approaches in analyzing consumption and saving behavior with both aggregate data and individual household data. We hope that it will stimulate further research on the issues we have raised and have attempted to begin to answer.

Appendix

We present below a brief description of the generation of the data used in our paper. (Further details are available upon request from the authors.) First, real after-tax rates of interest are derived from data on Moody's AAA-ten-year corporate bond yields, the automobile finance rate, Moody's AAA-twenty-year municipal tax-exempt bond yield and the implicit price deflator for personal consumption expenditures in the National Income and Product Accounts (NIPA). The expected inflation rate for the immediately succeeding period is generated by a distributed lag over the previous five periods with the weights assigned to different periods estimated by a maximum likelihood search procedure. As is usual in such studies, a heavy weight is obtained for the immediately past period. A risk premium for personal finance of 3% is estimated from a regression of the automobile finance rate against the corporate bond rate. The real after-tax rate of interest is derived as the municipal bond rate minus the expected inflation rate plus the 3% risk premium.

Second, we use the panel study of income dynamics (PSID) of 1972 to build an age-wage profile. The wage expected for a worker in any given year, at a future age, given his current age, as a ratio of his current wage, is assumed to be the same as that given by the ratio of standard hourly earnings predicted by the estimated earnings function which is assumed to be quadratic in age. Average marginal tax rates from Barro and Sahasakul (1983) are used to derive the after-tax wage rates.

Third, to measure the value of human capital, the expected present value of future earnings, for each age cohort, we generate an adjusted number of households of each age cohort from the baseline data in the Current Population Survey Report, Series P-20, Bureau of the Census. We

assume a full endowment of leisure of 4400 hours per year. The probability of survival at each age is generated from U.S. Vital Statistics. This gives us an estimated number of households by age cohort for each year from 1947 to 1980. These data combined with our estimates of expected future after-tax wage rates, and real after-tax rates of interest, give us an estimate of human wealth by age cohort for each year. When future earnings are discounted in our calculation of human wealth for each age cohort, we also discount by one minus the probability of survival at each age. While human wealth increases reflect the increase in adjusted male average hourly earnings from $1.27 in 1947 to $8.01 in 1980, the relative shifts among age cohorts are substantial. For example, human wealth between 1965 and 1975 increases 349% for the 25-34 age cohort, 219% for 35-44, and 220% for 45-54.

Fourth, the measurement of nonhuman capital by each age cohort starts with allocating aggregate NIPA property income by category for each age cohort for each year. We assume that the ratio of each category of property income to measured income by each age bracket is constant and is the same as that observed in the Consumer Expenditure Survey of 1972-73. The components of income (expense) include market rental income, the property income part of self employment income, personal interest income, dividend income, imputed rental income on own dwelling before interest payments, and interest expenses on own dwelling. By applying these ratios to the mean income for each age bracket in Series P-60 of the Current Population Survey, we obtain a preliminary time series of property income by age bracket. It is well known that survey data usually underestimates property income. Thus, for each category of property income, we calculate the ratio of the sum across age brackets to the aggregate NIPA figure and multiply the inverse of this ratio to our preliminary property income estimate for each age bracket.

Thus, the sums of estimated property incomes across age brackets are made consistent with the corresponding NIPA aggregates.

Each category of property income is capitalized to obtain the appropriate asset or debt value. The real after-tax rate of interest plus 3% risk premium is applied to all property income except interest income and expense. The personal interest yielding asset value is obtained by capitalizing personal interest income by the nominal corporate bond yield with a 3% risk premium. The debt value of owned-home mortgage, is derived by using the capitalization rate which would yield the aggregate mortgage value reported by the Flow of Funds Data of the Federal Reserve Board. Again, nonhuman wealth rises substantially from 1947-80, with pronounced changes in the age composition. Perhaps most interesting and important is the 473% rise in the nonhuman wealth of the 65+ cohort, compared to, for example, 183% for the 45-54 cohort and 294% for the 55-64 cohort.

Personal consumption expenditures from the National Income and Product Accounts, 1947-1980, form the basis for our basic consumption data. Leisure expenditure data are derived as the difference between full-wage income and NIPA wage income plus the labor income component of proprietors' income, which is estimated as 80% of the total reported. We do not attempt a full adjustment of the consumption series to include the service flows from consumer durables, but conform to the NIPA convention. This includes an estimate of imputed rent to owner-occupied housing as part of consumption, but not the services of consumer-owned durables.

From the Consumer Expenditure Survey of 1972-73, we can calculate the average consumption and leisure expenditure to wealth ratios for each age cohort. In deriving such ratios we adjust the per family consumption, wage income, and property income by age cohort, directly derivable from the Consumer Expenditure Survey, to match each data series with the

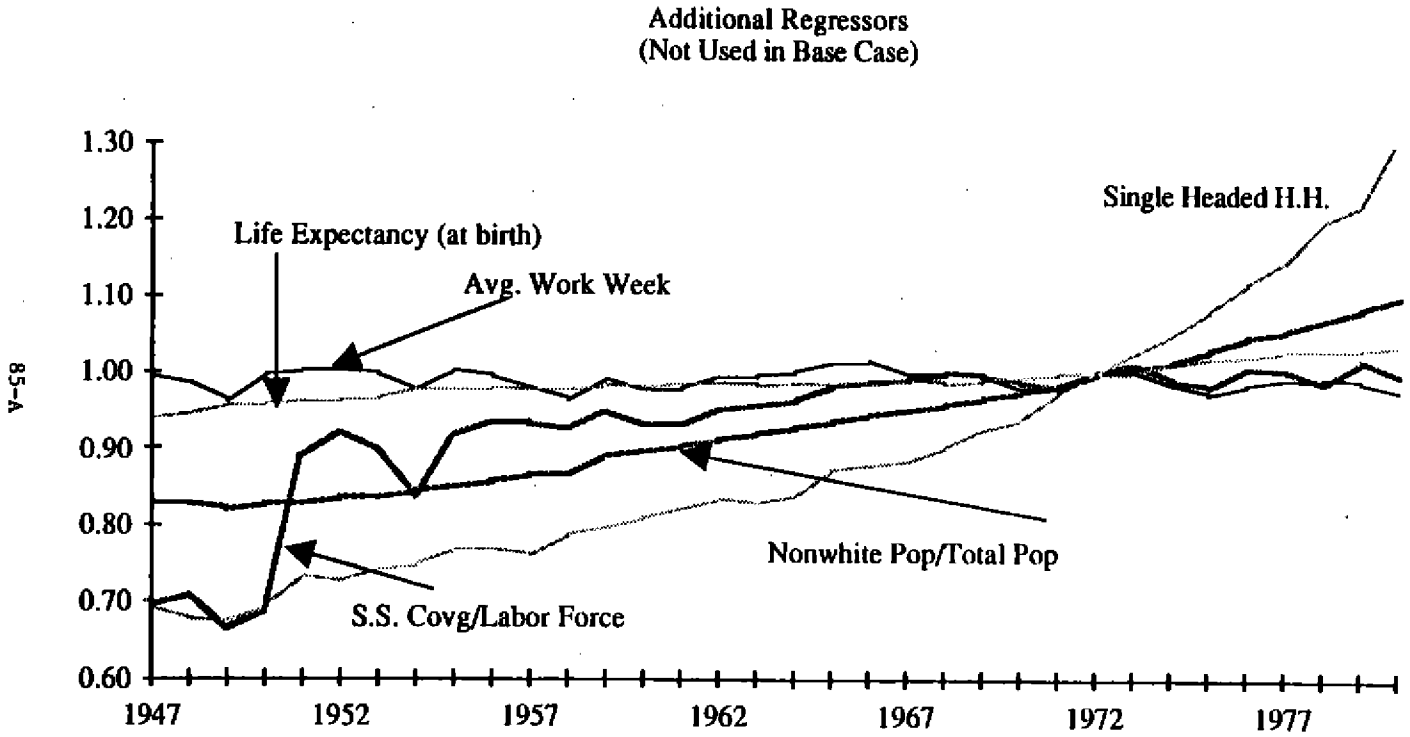
corresponding aggregate NIPA data when per family data are added up using the age distribution and the number of families from the 1972 Current Population Survey. While we do not constrain the level of the ratios other than that their weighted average conforms to the aggregate, we do impose a less restrictive assumption that the difference between the estimated ratios of each age cohort and the 45-year old age cohort in 1972 is equal to the actual difference in 1972.

Three additional regressors are used in the base case of our study. These are the female labor force participation rate, the logarithm of the prime age white male unemployment rate (taken, respectively, from the Bureau of Labor Statistics Bulletin and the Economic Report of the President) and the share of wealth held by households headed by persons born prior to 1939. Data on this last regressor is derived from the raw data. Because data on households by individual ages are not readily available on a year to year basis, we estimate the fraction of households born post-1939 by allocating the fractions within each cohort to specific ages. The data suggest (Current Population Survey Reports 1981, 1982) that only 7% of the households in the 14-24 cohort are headed by persons less than 20 years old. We thus allocate the cohort totals to individual ages to obtain that fraction which is presumed to have been born pre- and post-1939. For the older age cohorts, households are distributed more or less uniformly.

We also experimented with some additional economic and demographic regressors which might affect consumption and leisure. These include the proportion of single-headed households, life expectancy at birth, the fraction of non-whites in the total population, and the fraction of the labor force covered by Social Security, as well as various measures of "Social Security Wealth". In all cases, the inclusion of these variables is

not supported by standard statistical tests. Further, as Figure A.1 reveals, while many of these variables are trended, none of their paths are closely correlated with that of the share of wealth held by households headed by persons born pre-1939.

Figure A.1


Additional Regressors
(Not Used in Base Case)
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
1947
1952
1957
1962
1967
1972
1977
Life Expectancy (at birth)
Avg. Work Week
Single Headed H.H.
Nonwhite Pop/Total Pop
S.S. Covg/Labor Force

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