DETERMINANTS OF PRIVATE SAVING WITH SPECIAL REFERENCE TO THE ROLE OF SOCIAL SECURITY -- CROSS COUNTRY TESTS

Franco Modigliani
Arlie Sterling

Working Paper #1209-81

DETERMINANTS OF PRIVATE SAVING WITH SPECIAL REFERENCE TO THE ROLE OF SOCIAL SECURITY -- CROSS COUNTRY TESTS

Franco Modigliani

Arlie Sterling *

Revised

April 1981

Prepared for the International Economic Association Conference on the Determinants of National Saving and Wealth, Bergamo, Italy, June 9-14, 1980; forthcoming in a book of the proceedings of the conference, published by The MacMillan Press Ltd.

The authors would like to thank Stanley Fischer, Wolfgang Franz and Larry Summers for helpful comments.

* The authors are Institute Professor and graduate student respectively, at the Massachusetts Institute of Technology, Cambridge, Massachusetts.

INTRODUCTION

This paper is concerned with developing and testing hypotheses to account for the great diversity in saving behavior revealed by international comparison. In formulating the hypothesis, we rely on the life cycle hypothesis (LCH), developed initially by Modigliani and Brumberg [1954] and generalized by Feldstein [1974].

It is shown that the LCH, with its emphasis on accumulation for retirement as the primary motivation for saving, implies that the major determinants of inter-country variation in the saving rate are differences in the rate of growth of per capita income, length of retirement, and demographic variables relating to the age structure of the population. Another important factor is the availability of support for older people through social security arrangements. Particular attention is devoted to understanding and testing the implications of the LCH with respect to the impact of social security systems on aggregate private saving behavior.

In Part I of the paper we develop major implications of the LCH relevant to the analysis of cross country variations. In Section II we discuss the data used and the approximations necessary to test those implications. In Section III we report the empirical results.

The results suggest that the basic LCH framework developed here is capable of explaining a great deal of the international variation in savings behavior. With respect to social security we find evidence for the two effects suggested by the extended life cycle model, namely, a saving reducing replacement effect and a saving augmenting retirement effect. Somewhat surprisingly, our estimates suggest that these two effects roughly offset each other.

PART I -- THEORETICAL FOUNDATIONS

There are several ways to analyze the determinants of private saving and wealth within a life cycle framework. One may start from the individual household decisions, or saving functions, and then aggregate over individuals. Alternatively, one may wish to focus on the determinants of individual and aggregate wealth. The second approach is most useful when studying steady state implications. Indeed, with stable growth (or moderate fluctuations around a growth trend), the (private) saving rate, $\underline{s}$, averaged over cyclical fluctuations, can be expressed as the product of the rate of growth of income, $\underline{p}$, times the (private) wealth-income ratio, $\underline{a}$ (c.f. Modigliani [1966]):

$$(1) \qquad s = \frac{S}{Y} = p\frac{A}{Y} \equiv pa$$

Here S is aggregate private saving, Y is aggregate disposable income, and A is aggregate private wealth. We shall find it useful to rely on both approaches but will begin with the wealth ratio approach because we believe that it is most conducive to an understanding of the complex channels through which social security and (average) retirement age can affect saving and wealth.

I.1 Social Security and the Wealth-Income Ratio in a Stationary Society

As is well known, and obvious from (1), in a stationary society (p=0), $\underline{s}$ will be zero in steady states, independently of social security arrangements. But one can still inquire about the determinants of $\underline{a}$ in a stationary society.

The essential aspects of the problem can be adequately examined given assumptions of the elementary Modigliani/Brumberg model [1980]. Specifically, we assume that: (i) income accrues at a constant rate up to retirement, (ii) the rate of consumption during the W years of the working span, $\underline{c}$, is a constant, while retired consumption during the R years of the retirement span is a constant fraction, λ, of the rate during the working span, (iii) no bequests are received or planned, (iv) assets have zero (real) returns, and (v) the government performs no function other than administering the social security system.

For a stationary population we can also make the convenient assumption of a zero mortality until terminal age L, and one household in each age cohort. Let y denote annual average disposable income, t the social security tax rate, and SST total social security benefits. In the absence of bequests, the individual's life budget constraint takes the form:

(2) $$Ly = W(e - t) + SST = Wc + \lambda Rc$$

It follows that the rate of saving is a positive constant, e-t-c, up to retirement and then becomes a negative constant, $SST/R - \lambda c$ to age L. Thus, wealth rises linearly with age to a peak, $R\lambda c - SST$, representing the amount needed to finance that portion of retired consumption which is not covered by social security, and then declines linearly to zero over the R years of retirement.[1]

In view of the assumption of one household in each age cohort, aggregate private wealth is given by the area of a triangle of height $R\lambda c - SST$ and base $W + R = L$, or:

$$A = \frac{1}{2}(R\lambda c - SST)L$$

Since aggregate disposable income is $Y = Ly$, and making use of (2), the asset income ratio can be expressed as:

(3) $$a \equiv \frac{A}{Y} = (1 - \frac{Z^*}{\lambda L}\sigma)\, a(0)$$

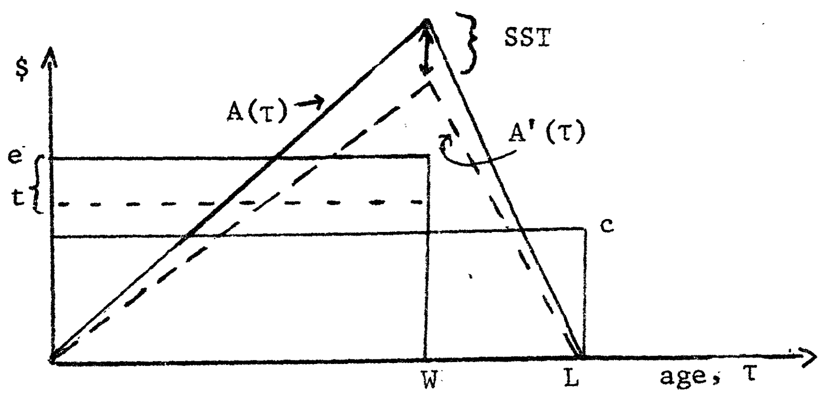
where $\sigma \equiv SST/Ry$ is the "social security replacement rate," $Z^* \equiv W + \lambda R$, and $a(0) = \frac{R\lambda L}{2Z^*}$ is the wealth income ratio in the absence of social security ($\sigma = 0$). Note that if σ is zero and in addition $\lambda = 1$, then (3) reduces to $a = R/2$, which is the result obtained by Modigliani/Brumberg [1980] for this basic model.

It is seen from (3) that if social security had no impact on the length of retirement R, then its effect would be that of reducing the wealth income ratio at the proportional rate:

$$\frac{1}{a}\frac{\partial a}{\partial \sigma} = -\frac{1}{2}\frac{R}{a} \tag{4}$$

Saving and wealth are reduced even though consumption is unchanged -- which it will be as long as social security contributions exactly offset benefits, leaving life disposable income unchanged -- because of the rise in contributions, t, and consequent reduction in disposable income during the working span. This effect of social security on the pattern of accumulation, which Feldstein [1977] has labeled the wealth replacement effect, is shown graphically in the figures based on the standard graph from Modigliani [1966]. It could be of substantial magnitude.

FIGURE 1. The Wealth Replacement Effect of Social Security



—— $A(\tau)$ = wealth at age τ in absence of social security
- - - $A'(\tau)$ = wealth at age τ with social security benefits equal SST

Thus, if λ were say 0.8, L = 50, R = 10 and W = 40, one can deduce from (3) that an increase of σ from .2 to .3 would reduce a by roughly 16 percent. But it should be recognized that a decline in the private wealth ratio need not imply an equal decline in the ratio of aggregate capital to income -- that depends on the financing of government and, in turn, on the extent to which the liabilities of the social security system are funded. This point is stressed by Eisner [1980] and Hymans [1981].

In reality, equation (5) provides but a partial inference about the impact of social security on the wealth-income ratio, for it neglects possible effects a through R which, as can be seen from (3), is a major determinant of a. Differentiating (3) with respect to σ, but recognizing that R is also a function of σ, (and assuming λ independent of σ), one obtains:

$$(5) \qquad \frac{da}{d\sigma} = -\frac{R}{2} + \frac{1}{2}\left[\frac{2a}{R} + \frac{\lambda(1-\lambda)RL}{(W+\lambda R)^2}\right]\frac{dR}{d\sigma}$$

The first term is again the private wealth (or saving) replacement effect and is necessarily negative. But there is an additional effect given by the second term of (5). It can be expected to be positive, if, as we shall argue in the next section, a larger value of σ and associated higher contributions encourage earlier retirement so that $\frac{dR}{d\sigma} > 0$. This arises because basically a longer retirement span, R, requires the accumulation of a larger wealth to finance retired consumption, $R\lambda c$.

In view of these contrasting and offsetting responses, it is impossible to reach a definite conclusion, not only about the magnitude but even the sign of $\frac{da}{d\sigma}$, until we have considered the behavior of $\frac{dR}{d\sigma}$ in a later section. For $\frac{da}{d\sigma}$ to be positive, however, requires that $\frac{dR}{d\sigma}$ be rather large, roughly between 6 (at $\sigma = 0$) and over 16 (at $\sigma = 0.3$).[2]

I.2 Extensions to Non Stationary Economy

In order to extend the analysis to a non stationary economy, we rely on a fairly straightforward generalization of the approach pursued by Modigliani [1970]. It uses the technique of summing up saving over all cohorts, taking into account the effect of productivity growth and of family size as well as of retirement. To this end, let w, r and 1=w+r stand for active, retired and total population. In addition, let D denote the average number of 'minor' years attached to a household over its life cycle, d the actual number of dependents, and λ_d the average yearly rate of consumption expenditure per minor relative to the rate of expenditure per active adult. Finally, define Z as $Z \equiv W + \lambda R + \lambda_d D$; it represents the length of life measured in terms of equivalent consumption years. One then arrives at the following expression for the saving ratio:

$$(6) \qquad s \equiv \frac{S}{Y} \approx \frac{S}{we} = (1 - \frac{Z}{\lambda L}\sigma)\ s(0)$$

where

$$(6a) \qquad s(0) = [1 - \frac{W}{Z}(1 + \lambda\frac{r}{w} + \lambda_d \frac{d}{w}) + \alpha_5\rho\ ]$$

is the saving rate in the absence of social security as derived in Modigliani [1970], equation (19)(except for obvious notational differences and for the last term approximating the effect of productivity growth, ρ, (which is omitted in (19)). The first factor in (6) is very similar to that in (3). The only difference is that, in the coefficient of σ, Z^* is replaced by Z which allows for the effect of dependent population D. It follows that the replacement effect of social security is basically the same non linear one in a stationary and non stationary economy. It necessarily reduces saving (or wealth) though not linearly but rather by a <u>fraction</u> of what it would have been in the absence of social security, as given by s(0). The induced retirement effect will still tend to increase saving since the first and especially the second factor in (6) are increasing functions of R.

As shown in Modigliani (op. cit.), s(0) in (6) can be expected to rise with productivity (i.e. $\alpha_5 > 0$) because older generations are then richer and saving at a rate more than offsetting the dissaving of the retired. The second term of s(0), $\frac{W}{Z}(1 + \lambda\frac{r}{w} + \lambda_d \frac{d}{w})$, shows the effects of population structure; clearly, saving will tend to decline in response to a rise in the proportion of retired population, $\frac{r}{w}$, or dependent population, $\frac{d}{w}$. A rise in population growth will tend to affect these two ratios in opposite directions, but should on balance increase saving since the effect of the smaller retired fraction should outweigh that of larger dependency ratio.

Equation (6) was derived assuming that the entire population is covered by social security and with the same replacement rate. To generalize to the case where one or both assumptions do not hold, let n_1 and n_o be the fractions of covered and non-covered population. If the two groups are similar with respect to the mean value of other variables, so that s(0) is the same for both groups, then the national average saving ratio, being the weighted average of each groups' saving rate, will be given by (6) but with σ replaced by the "effective" average replacement rate, $n_1\sigma$. If the two groups differ significantly in terms of some other arguments, modifications to (6) would be called for, though we shall ignore this complication.[3]

I.3 Some Qualifications

Before concluding this section, we must call attention to certain mechanisms which could cause the replacement effect to be less negative -- possibly much less -- than implied by (6).

One relates to the provision of retirement support through children. From the point of view of the accumulation of private wealth, what matters is λRc - (children support) - SST. This quantity may well remain unchanged as SST comes into being or rises, as this may be accompanied by a roughly equal decline in children support -- implying no replacement effect. From the point of view of the working children, the lower support is offset by higher social security contributions, leaving accumulation unchanged.

Another effect, stressed by Dolde and Tobin [1980], works through the fact that saving is partly motivated by reasons other than retirement -- e.g., to acquire a house. Illiquid social security benefits cannot be used to satisfy these other purposes of saving while many types of private saving can. Hence, if the non-retirement use of saving is significant, the replacement effect will be diminished.

These considerations suggest that in (6) the coefficient of σ should be multiplied by a further factor smaller than unity -- though how much smaller cannot be established a priori.[4]

PART II -- DERIVING A TESTABLE EQUATION AND THE DATA USED IN ESTIMATION

We endeavor to test the significance of the life cycle variables discussed above via estimation of an equation derived from (6) for a cross section of countries, with individual variables generally measured as averages over the decade 1960-1970. The sample consists of 21 OECD countries, for which time series data for the period 1960-1970 are available. By using averages and international cross-sectional data we hope to capture long run relations across a broad range of social, economic and demographic conditions. This approach has been successfully applied by Houthakker [1965], Modigliani [1970], Feldstein [1977, 1979], Leff [1969], and Kopits and Gotur [1979], to mention but a few. A complete listing of the data by country is given in an appendix.

Implementation of (6) requires measurement of the savings ratio, rate of growth of productivity, population age distribution, length of retirement, and the fraction of annual lifetime average disposable income replaced by social security benefits. In this section we describe in some detail the approach taken in deriving approximations to the relevant variables and the data used in implementing these approximations.

II.1 Saving and Income

Our dependent variable is throughout the private savings ratio -- the ratio of the sum of personal and corporate savings to private consumption plus private savings. We thus follow other authors in treating corporate savings as a perfect substitute for private savings.[5] Savings and consumption data are from the OECD [1973]. The private savings ratio for each country is then the average of 11 observations from 1960 to 1970.

The relevant rate of growth of productivity is that of real per capita disposable income. It was estimated as the slope of b of the regression equation: $y_t = a + b \cdot t$, where y is the natural log of the income measure defined above, deflated by indices of population and price level from the OECD [1980]. The fit of the income growth equations was uniformly excellent.

II.2 Demographic Characteristics

The age distribution variables, $\frac{r}{w}$ and $\frac{d}{w}$, reflect differences in growth rates and variability in these rates over the relevant past, as well as retirement and family size preferences. A straightforward measure of the incidence of retirement is given by the ratio of aged people not working to the total working population. The trouble with this measure is that it treats as retired some people that have never been in the labor force, notably homemakers. One way around this problem is to confine the numerator and denominator to males only, though at the expense of excluding from the measure the effect of differential behavioral patterns of female participation in the (measured) labor force. In what follows we make use of three alternative measures of the proportion retired, namely: 1) all non-working people above the minimum age of retirement for social security purposes, relative to the population 20 and above; 2) all non-working men above the age of 55 relative to the male labor force; and 3) all non-working men above the age of 65, relative to the male labor force.

Measuring the fraction of the young presents less serious difficulties. We use two measures: 1) all people below the age of 20 relative to the population 20 and above; and 2) all children below the age of 15 relative to the male labor force.

Population and labor force estimates are from the OECD [1979] and are averages of the 1960 and 1970 observations.

II.3 Length of Working Life

The expected length of working life, W, can be expressed as the difference between the expected length of active life, L, and the expected length of retirement, R, which can be measured as life expectancy at any given age weighted by the fraction of all retirees retiring at that age.

Consider a 2-period 2-generation world, in which people may retire at the end of the first period but, if they do not, work until death (at the end of the second period). As Reimers [1976] points out, if we may ignore net migration and temporary withdrawals, the number of retired can be expressed as:

$$\text{number retired} = (LFPR_1 - LFPR_2)P_2$$

where $LFPR_i$ is the labor force participation rate in cohort i, and P_i the population of cohort i. Now, if everyone retires at the end of period 1, the average length of retirement is simply LE_1, the life expectancy at the end of period 1. If, however, some people choose not to retire, the average length of retirement will be a weighted average of LE_1 and 0. Indeed, it will be precisely:

$$(7) \qquad R = LE_1 \frac{(LFPR_1 - LFPR_2)P_2}{LFPR_1 P_2} + 0 \frac{LFPR_2 P_2}{LFPR_1 P_2} = LE_1 \frac{LFPR_1 - LFPR_2}{LFPR_1}$$

where R is the average length of retirement for those in the labor force.

Equation (7) suggests a simple way of approximating R in our sample. For the first age group we choose men aged 25-54, and for the second group men 65 and over. Using this approximation requires that we interpret LE_1 as the average life expectancy at retirement for all those who retire -- not just those who retire at 65.[6]

We may now use (7) to calculate the approximate length of working life:

(8) $$W \equiv L - R = A - B\Delta PR$$

where $A \simeq L$, $B \simeq LE$, the average expectation of life upon retirement, and ΔPR the ratio (Participation Rate 25-54 - Participation Rate 65 and over) / Participation Rate 25-54.

II.4 Test Equation

In order to carry out estimations and tests we have to make the assumption that certain variables can be approximated as constant across countries to be estimated from the sample. Specifically, we will make these assumptions for L and LE, and hence A and B in (8), as well as for Z and the λ's which have been defined earlier in connection with (6). Then, using (8) to substitute for W in (6), and taking into account the implication of incomplete coverage, we can write:

(9) $$\frac{S}{Y} = (1 + \alpha_o n_1 \sigma)[\alpha_1 + \alpha_2 \frac{d}{w} + \alpha_3 \frac{r}{w} + \alpha_4 \Delta PR + \alpha_5 \rho + \alpha_6 (\Delta PR)\frac{d}{w} + \alpha_7 (\Delta PR)\frac{r}{w}]$$

The coefficients $\alpha_o \ldots \alpha_7$ are related to the underlying behavioral and institutional parameters as follows:

$$\alpha_o = -\frac{Z}{\lambda L} \qquad \alpha_1 = 1 - \frac{L}{Z} \qquad \alpha_2 = -\frac{\lambda_d L}{Z} \qquad \alpha_3 = -\frac{\lambda L}{Z}$$

$$\alpha_4 = \frac{LE}{Z} \qquad \alpha_6 = \lambda_d \frac{LE}{Z} \qquad \alpha_7 = \lambda \frac{LE}{Z}$$

For the sake of getting some rough notion of the value of the above coefficients consistant with the LCH, let us take D = 20, W = 40, and LE = R = 10, and therefore L = 50. These values are consistant with those implied by the age distribution variables in countries with little population growth. We further guestimate that λ, the retired rate of consumption relative to the working year rate, can be placed at .8, and that λ_d, the rate of expenditure per minor year relative to the working rate, at .4. These values imply an estimate for Z of 56 and for L/Z of .89 -- estimates which are relatively robust to reasonable variations in the above assumptions.[7] The implied values for the parameters of (9) are given in the table below.

Table 1. *A Priori* Estimates of the Coefficients $\alpha_o \ldots \alpha_7$

α_o	$= -1.4$	α_1	$= 0.11$
α_2	$= -0.36\ (-0.31)$	α_3	$= -0.72\ (-0.62)$
α_4	$= 0.18\ (.24)$	α_6	$= 0.07$
α_7	$= 0.16$		

The productivity growth coefficient, α_5, has been shown by Modigliani [1970] to be a function of the marginal propensities to consume out of labor income and assets. Based on reasonable values for these parameters we expect α_5 to be between two and three.

In estimating (9) we will actually drop the last two product terms since multicollinearity with the three variables involved in the product makes it impossible to estimate reliably the coefficients α_6 and α_7 which are, anyway, fairly small. This has the effect of "biasing" the estimates of α_2, α_3, α_4, upward the last and downward the other two. The figures given in parentheses for α_2, α_3, and α_4 represent the estimated effect of the bias. Needless to say, the values we have assigned to λ and λ_d are little more than guesswork, and the interested reader may readily recompute the α's using other assumptions.

Equation (9) and the above estimates assume that the social security system is in steady state with respect to the relation between contributions and benefits current and perspective. This assumption is certainly questionable in view of the relatively recent formation and/or major revamping of the social security system of several countries in our sample. We have not attempted to deal with the behavior of the saving rate during periods of transition because it depends intimately on the details of the transitional arrangements which are not readily available or quantifiable.[8]

II.5 Social Security Benefits

The remaining problem in estimating (9) is the measurement of the effective social security replacement rate, $n_1\sigma$, which turns out to involve rather serious problems. One possible way to estimate this variable is to assume that σ may be approximated by the ratio of social security benefits (SS) per recipient to average income, y, and n_1 by the ratio of recipients to the number eligible, which could be identified as those retired above the minimum age required for retirement.[9] Thus:

$$\sigma n_1 = \frac{SS}{Recipients} / y \quad x \quad \frac{Recipients}{Retired} = \frac{SS}{Retired} / y$$

This measure can be computed for every country in the sample from information on total pension benefits from the ILO and on the number of retired from OECD [1979].

An alternative approach is to secure direct estimates of the replacement rate of the covered group, σ, and of the coverage rate, n_1. Olsen [1978] has estimated replacement rates for several countries, assuring comparability across countries by basing his estimate on a standardized situation. Specifically, he measures the ratio of social security benefits to average income in the relevant years preceeding retirement for men in manufacturing. The replacement rate is computed both for single men and for couples. Unfortunately, his sample includes but 12 of 21 countries.[10] Information on the coverage ratio is even more scanty: an estimate may be computed from data on recipients from OECD [1977, Table 2.1], but this estimate appears subject to considerable error and, in any event, is available only for nine countries of which but seven overlap with the twelve countries covered by Olsen. For these seven countries, we show in Table 2 the direct estimate of n_1 - column (1) - the Olsen estimates of the replacement rate for couples, σ - column (2) - their product representing the direct estimate, $n_1\sigma$ - column (3) - and finally the alternate measure of $n_1\sigma$, based on the ILO source - column (4).

Column (1) indicates that, not unexpectedly, coverage is quite similar for the seven countries and also quite high (with the United States somewhat of an

TABLE 2. A Comparison of Effective Replacement Rate Measures

Country	(1) Coverage Rate* (n_1)	(2) Replacement Rate (σ) Olsen	(3) Effective Replacement Rate ($n_1\sigma$) (1) x (2)	(4) Effective Replacement Rate ($n_1\sigma$) ILO
Canada	0.96	0.42	.40	0.25
Denmark	0.97	0.51	.49	0.35
Netherlands	0.86	0.50	.43	0.57
Norway**	0.84	0.38	.32	0.43
Sweden	0.90	0.44	.40	0.40
UK	0.99	0.36	.36	0.35
US	0.74	0.44	.33	0.27
mean	0.89	0.44	.39	0.37

*Average of 1960 and 1970.

**The minimum age of retirement in Norway was 70 for this period. The eligible reported here, however, are those over 65.

- - - - - - - -

exception). Accordingly, the estimate of the effective replacement rate is very similar to the replacement rate, though somewhat smaller. Unfortunately, this estimate of the effective replacement rate appears to bear little relation to the alternative ILO estimate. There are, to be sure, some conceptual differences between the estimates of columns (3) and (4), and some reason to think that the Olsen replacement rates may be downward biased.[11] But it is hard to account for a nearly total lack of correlation between the two estimates.

Clearly, if one is prepared to accept the Olsen estimate as a sound measure of the replacement rate, one is led to suspect that there may be a good deal of noise in the ILO estimate, perhaps because their estimate of benefits includes payments other than social security benefits.

On the whole, the comparisons of Table 2 strongly suggest that, for those countries for which they are available, estimates of the effective replacement rate based on the Olsen data may well be more reliable than those of the ILO. Furthermore, the high and stable coverage ratio of column (1) suggests that the "effective replacement rate" available for only seven countries, can be replaced with the replacement rate of column (2) which is available for 12 countries. Therefore, for the Olsen sample of 12 countries, one can use as a measure of social security benefits either the ILO adjusted replacement rate or the Olsen replacement rate, with the latter measure somewhat upward biased but probably a more reliable indicator of variations across countries.

For the full sample of 21 countries, one can also use the Olsen measure wherever available and the ILO measure otherwise, as well as the ILO measure alone. By mixing the concepts in the full sample, we are able to gain efficiency in the estimation of the non-social security parameters through a larger sample, but still utilize all the information available in the Olsen data.[12] To allow for differences in the relation between the true social security measure and the two alternate approximations, we allow each of the two measures a different coefficient in the full sample.

PART III -- THE EMPIRICAL RESULTS

Our tests of the LCH are primarily attempts to see if the lifetime budget constraint and planning period implicit in (2) are relevant for the representative individual. They are simultaneously tests of the validity of the approximations we imposed to generate a testable equation. These issues are addressed by the significance of the α coefficients and their magnitude relative to our *a priori* estimates, and the comparative fit of the nonlinear versus linear specification. Also relevant is the sensitivity of our results to changes in specification and to any particular subset of data within the sample.

All the regressions reported below were estimated using a GLS technique to correct for heteroskedasticity. The variance of the residuals was taken to be proportional to the sample variance of the savings ratio divided by the mean population in each country, which weights more heavily large countries with stable savings ratios. The United States has the highest weight (16 percent of the total weight).[13]

The weights are given in the Appendix.[14]

III.1 The Replacement Effect

Initial results, not presented here, give us confidence that the life cycle variables other than social security have a significant and robust impact on the savings rate. In particular, the measure of retirement span, an innovation of this study, is quite significant. The direct effect of social security, however, proved more difficult to estimate. We thus proceed first to a discussion of the social security effect.

Rather than present the full set of coefficient estimates for each of the various samples and concepts discussed above, we will use an abbreviated format to get a broad overview. For each equation in Table 3, we report only the estimated coefficient on social security and its t-ratio, as well as the standard error of the equation. We rely on two samples. The top part of the table relates to the full sample of twenty-one countries and the lower part to the "Olsen" sample of twelve countries. For each sample we show results for two alternative measures of social security replacement rate, $n_1\sigma$. Within each set, in equation (1), the retired fraction, r/w, is measured by the ratio of non-working people above the minimum age of retirement for social security purposes relative to population over 20, and the dependency rate, d/w, by people below the age of 20 to population over 20. In equation (2), the measure of d/w is the same, but r/w is the ratio of retired men above 55 to the male labor force. In equation (3), r/w is the same all male measure used in (2), but the dependency ratio is people below the age of 15 to male labor force.

Look first at the left portion, when the social security measure is the ratio of benefits per retired person from the ILO to per capita income. The results are rather discouraging. In no case is the coefficient of the expected order of magnitude or significantly negative. Indeed, in the preferred equations,

TABLE 3. Savings Ratio Equations -- Various Measures of Social Security*

$$\text{(T.3)} \quad \frac{S}{Y} = (1 + \alpha_o n_1 \sigma)(\alpha_1 + \alpha_2 \frac{d}{w} + \alpha_3 \frac{r}{w} + \alpha_4 \Delta PR + \alpha_5 \rho)$$

Equation	α_o (ILO)	S_e	α_o (Olsen)	α_o (ILO)	S_e
I.1	-0.12 (0.56)	5.02	-0.20 (0.84)	-0.55 (1.36)	4.97
I.2	0.28 (1.18)	5.04	-0.31 (1.60)	-0.67 (1.81)	5.03
I.3	0.26 (1.22)	4.72	-0.30 (1.64)	-0.67 (1.95)	4.67
I.4			-0.43 (2.83)	-0.84 (2.53)	5.02
II.1	-0.23 (0.59)	4.54	-0.16 (0.31)		4.59
II.2	0.51 (2.01)	3.95	-0.50 (1.61)		5.08
II.3	0.49 (2.11)	3.70	-0.50 (1.73)		4.82

*Equations I.1 - I.4 are estimated for the full sample, II.1 - II.3 over the Olsen sample of 12.

the coefficient has the wrong sign and significantly so for the 12 countries sample. Sensitivity analysis (along the lines of Belsley, Kuh and Welsch [1980]) shows that the results presented in the table are not swayed by any one particular country.

The estimates reported in the remainder of the table, however, present a considerably different picture. The lower right portion reports the outcome of tests measuring social security benefits by the alternative measure available for 12 countries, namely the Olsen replacement rate. The remarkable result shown is that, for this sample, the two measures give diametrically opposite results. For the ILO measure, the results are pretty much the same as for the total sample. But when we use the Olsen measure: (i) the coefficient is always negative as expected,

(ii) in equations (2) and (3) (which, however, do not give the lowest standard error for this sample), it has a reasonable order of magnitude, and (iii) in the last equation it approaches significance by the appropriate one-tail test. Sensitivity analysis shows that deletion of Switzerland appreciably increases both the point estimate and the significance of the coefficients of both the Olsen and ILO variables (thus pulling them further apart).

In the light of these contradictory results we proceed to reestimate an equation for the full sample using a mixed measure of the replacement rate, namely the Olsen measures when available and the ILO measure for the 9 countries for which it alone is available. To allow for different elasticities of the true variable with respect to the measured variables, we allow these two measures to have different coefficients, which are reported in the top right side of Table 3. The results are rather suggestive. Looking first at the specifications I.1 to I.3, one finds that the coefficient of the Olsen variable is negative in every row, though in the first row it is somewhat on the small side. In addition, the coefficients of the ILO measure also become negative and significant at the 5 percent level or better. The positive correlation between saving and the ILO measure of social security for the full sample is evidently due to a strong positive association within the 12 country sample.

These encouraging results are further supported by the estimates presented in row I.4. They correspond to an alternative measure of the incidence of retirement, namely the ratio of non-active men over 65 (rather than 55) to active men. Though this specification results in a higher standard error than that for I.3, in many ways it seems the most appropriate way of measuring intended retirement in a life cycle context, especially since the apparent substantial differences in the incidence of non active men in the 55 to 65 age group are perplexing. With this specification, the coefficient of both social security measures are significant at the one percent level or thereabouts and, especially for the ILO, are of an order of magnitude which approaches consistency with the implications of the model.[15]

III.2 The Role of Other Life Cycle Variables

In the first two rows of Table 4 below, we report the full set of estimated coefficients for the mixed social security measure equations I.3 and I.4 of Table 3. It is apparent that these equations yield very similar estimates of the effect of all variables, except for the larger social security effect in I.4. Furthermore, comparison with Table 1 shows that, leaving again aside the social security variables, the coefficient estimates are remarkably close to the values suggested by the life cycle (allowing for the fact that the measurement of d/w in the empirical equation implies a coefficient, α_2, roughly half as large as suggested in Table 1), though α_4 is a bit high. These coefficients are, in addition, quite robust with respect to single country deletion.

Equation I.4 provides a test of one further specification, which was shown earlier, is to be a direct implication of LCH, namely that the replacement rate should enter in a multiplicative rather than an additive fashion. This specification was

TABLE 4. Savings Ratio Equations -- Complete Coefficient Estimates

$$\text{(T.4)} \quad \frac{S}{Y} = (1 + \alpha_o n_1 \sigma)(\alpha_1 + \alpha_2 \frac{d}{w} + \alpha_3 \frac{r}{w} + \alpha_4 \Delta PR + \alpha_5 \rho)$$

Equation	α_o Olsen	α_o ILO	α_1	α_2	α_3	α_4	α_5	S_e	SSR
I.3	-0.30 (1.64)	-0.67 (1.95)	-0.01 (0.08)	-0.12 (4.59)	-0.65 (2.18)	0.37 (3.23)	3.00 (7.39)	4.67	305.6
I.4	-0.43 (2.82)	-0.84 (2.53)	0.02 (0.19)	-0.14 (4.35)	-0.61 (1.33)	0.35 (2.60)	2.85 (6.04)	5.02	352.6
I.4*	-0.09 (1.99)	-0.16 (1.87)	0.05 (0.86)	-0.11 (3.97)	-0.48 (1.22)	0.27 (2.69)	2.33 (7.59)	5.31	394.3

*Social security enters linearly.

imposed on all equations reported so far, including I.4. Equation I.4* differs from I.4 only in that the replacement rate is entered additively. It is seen that the linear specification yields estimates consistent with the non linear one but results in a standard error some 6 percent larger. Similar results were obtained for other specifications tested.[16]

III.3 Assessment of Test Results

On the whole, it would seem that our results provide support for the LCH, quite strongly so for the role of the demographic variables and the growth rate, though rather weakly so in the case of the social security replacement rate. Our estimates of the replacement effect suffer from three weaknesses. First, the significance of the coefficients is uncomfortably sensitive to alternative measures of the demographic variables. Second, the point estimates are well below the *a priori* value of Table 1, namely I.4. Though, as we mentioned in Section I, there are a number of reasons why the replacement effect could fall short of the value derived from the simple LCH, the difference does appear rather large.

Last but not least, the social security coefficients for the full sample appear to be very sensitive to some extreme observations. In particular, eliminating Japan from the sample -- an extreme country because of its very high saving ratio and low social security benefits -- causes the coefficient of the ILO variable to lose any significance. Somewhat surprisingly, this happens to the coefficient of the Olsen variable as well, though Japan is not one of the Olsen countries. At the other extreme, if one drops Ireland, another of the nine countries, *both* coefficients rise by 20 percent (becoming significant at the one percent level or better for all specifications). Dropping both Ireland and Japan leads to estimates just a bit lower than those for the full sample.[17]

III.4 The Sources of International Differences in the Saving Rate

In Table 5, column (1), we show how the life cycle variables which we

TABLE 5. Contribution, by Component, to the Savings Rate

Component	Sample Mean	U.S.	Japan
		Contribution to Deviation from the Mean	
(1) Constant	2.0	0.0	0.0
(2) d/w	-12.7	-2.8	-0.2
(3) m/w	- 6.9	0.1	4.0
(4) ΔPR	24.5	0.2	-8.6
(5) ρ	11.5	-2.5	11.3
(1) +...+ (5)	18.4	-5.0	6.5
(6) reduction due to social security (%)*	20.7	-1.7	-17.3
Savings Rate (%)			
(7) (6) * (7)/100	14.6	-3.8	9.4
(8) actual	14.5	-4.2	9.6

*For the sample mean, the social security effect is an average of the ILO and Olsen measures; for the U.S. and Japan it is the Olsen and ILO measure respectively.

have examined and tested account for the sample mean saving rate. Each entry in the second column is the product of the mean value of the variable indicated in the first column by the coefficient as estimated in equation I.4. It is seen that the saving rate reflects a balance between two large negative factors -- the dependency ratio and the proportion of population retired -- and two even larger positive factors -- length of retirement and productivity growth. Social security reduces the saving rate by an amount depending on the replacement rate. For our sample that reduction amounts, on the average, to some 20 percent, nearly 400 basis points. (Note that the linear I.4* implies a somewhat larger replacement effect.) Most of the variation in savings rates arises from income growth and length of retirement, while the two demographic variables vary less and tend to systematically offset each other (c.f. data appendix).

The second and third columns of the table further show how our equation accounts for two well known puzzles: the well-below average saving rate of the U.S. and the exceptionally high saving rate of Japan. The low savings rate in the U.S. is accounted for by a below average rate of growth of income and relatively high dependency ratio. The extremely high Japanese savings rate is largely due to a high rate of growth of income. Though the Japanese have a relatively short retirement span and thus lower planned saving, there are relatively few retired people currently dissaving. The effect of social security in the United States is roughly average, while in Japan the below average replacement rate accounts for more than 400 basis points of the excess savings rate.

It should be emphasized that the reductions attributed to social security above refer to the direct or replacement effect alone. Estimates of the total effect of social security appear below.

III.5 Retirement Behavior

The results presented above confirm the empirically significant role of retirement in accounting for international differences in savings behavior. In this section we try to explain observed variation in retirement behavior with particular reference to the role of social security. This will complete our empirical analysis of the extended life cycle theory in which retirement behavior as well as saving are endogenous.

For a utility maximizing individual, and supposing that retirement is not inferior, the retirement span will be a decreasing function of the price of retirement, and an increasing function of the individual's initial wealth. The impact of a change in the wage rate is ambiguous as it generates both an income effect, tending to increase the length of retirement, and a substitution effect tending to reduce it.

The price of retirement is the amount of consumption that must be foregone to lengthen the retirement span. To find the change in lifetime consumption, C, required by an increase in the retirement span, we may differentiate the budget constraint and substitute for y to obtain:

$$\frac{1}{C}\frac{dC}{dR} = \frac{-L(1-\sigma)}{(L-R)(L-\sigma R)} = \frac{(1-\sigma)}{L(1-\frac{R}{L})(1-\sigma\frac{R}{L})}$$

where the reduction is expressed as a proportion of total consumption. It can be easily seen that the cost in terms of consumption is a decreasing function of σ, and is exactly zero at $\sigma=1$. Since R/L is relatively small compared with unity, we will approximate the foregone consumption by a linear function of σ.

In deriving the cost of retirement, we assumed that individuals took σ as given. Actually, under most social security systems, it is possible for the individual to influence the replacement rate. Deferred retirement bonuses and/or means tests are two common mechanisms by which σ is partially endogenized. Unfortunately, it is a difficult empirical matter to summarize the relevant features of each country's social security system. The measure we were able to put together, which showed the influence of deferred retirement benefits and means tests on the replacement rate, had the expected effect on retirement when added to the equations of Table 6, but was rather insignificant.

We measure the wage rate by real GDP (in 1,000 US dollars) per worker, converted to constant US dollars by Summers, Kravis and Hester [1980], on the basis of detailed purchasing power parity information. We believe this measure of productivity is preferable to the more conventional per capita income, which as Eisner [1980] and Hu [1979] have stressed, is an endogenous variable, reflecting in particular the retirement choice. We have experimented with several specifications for the wage rate variable in an attempt to capture the possibility that the income effect is dominant at lower incomes, but becomes less so at higher incomes. While Feldstein endeavored to model this effect by using both a linear and a reciprocal of income term, we have been most successful with the natural log of income.

Households face an additional influence not felt by the single individual, as the expenditures necessary to raise a family divert resources from consumption and retirement. Since children may in turn support their parents, this diversion of resources should be viewed as net of any back-bequest. Altogether, children presumably reduce the resources available for their parents' consumption and retirement, and thus shorten planned retirement. We measure the influence of family size on retirement by the fraction of the population under 15 relative to the male labor force.

Table 6 shows the estimated retirement equations, which were estimated using a GLS technique to correct for heteroskedasticity, on the assumption that the variance of the residuals is proportional to mean population. The first two rows indicate a surprisingly large effect of social security on retirement behavior, whether measured by the ILO or by the mixed ILO-Olsen measure. The coefficients of (6.2) imply that $d\Delta PR/dn_1\sigma$ is roughly 0.65 and, given a life expectancy at retirement of roughly 10 years, suggests that $dR/d\sigma \simeq 6.5$. The results of row 3 provide support for the hypothesis that a higher per capita income tends to lengthen retirement, while a larger incidence of dependents tends to shorten it.[18]

TABLE 6. The Retirement Equation Estimates

(T.6) $\Delta PR = \beta_o + \beta_1 n_1 \sigma + \beta_2 \ln(y) + \beta_3 \frac{d}{w}$

Eq.	β_o	β_1 Olsen	β_1 ILO	β_2	β_3	S_e	SSR
6.1	0.51 (13.26)		0.64 (5.09)			0.47	4.13
6.2	0.45 (12.19)	0.59 (7.08)	0.72 (2.74)			0.37	2.40
6.3	0.59 (6.49)	0.43 (5.20)	0.74 (3.46)	0.16 (3.14)	-0.41 (3.16)	0.29	1.39

III.6 The Total Impact of Social Security

As we have seen in the first section, social security has two offsetting effects on saving: a direct negative "replacement" effect, and an indirect positive effect, as a rise in the replacement rate lengthens retirement, which in turn raises the saving rate. Though one might suspect that the direct effect would be likely to dominate, leading to a negative overall effect, the issue cannot be settled a priori.

Feldstein [1977, 1979] has reported evidence that the net effect of social security is definitely to reduce saving. What inferences can be drawn from the estimates presented here?

Relying on specification (T.3) of Table 3, we can write:

$$\frac{d\frac{S}{Y}}{dn_1\sigma} = \alpha_o S(0) + (1 + \alpha_o n_1 \sigma)\frac{dS(0)}{d\Delta PR}\frac{d\Delta PR}{dn_1\sigma} \tag{10}$$

where $S(0) = \alpha_1 + \alpha_2 \frac{d}{w} + \alpha_3 \frac{r}{w} + \alpha_4 \Delta PR + \alpha_5 \rho$. Now $\frac{d\Delta PR}{dn_1\sigma}$ is the coefficient β_1 in equation (T.6), the estimate of which is found in Table 6, Row 3 (it has of course two values for the two measures of social security). The coefficient $\frac{dS(0)}{d\Delta PR}$ presents somewhat of a problem. Though, according to (T.4) the partial derivative of S(0) with respect to ΔPR is given by α_4, the total derivative must take into account the effect of ΔPR on other variables, in particular, the retirement ratio r/w. This ratio is largely determined by two variables: the retirement habits measured by ΔPR and the age structure as measured by the proportion of people having reached the retirement age -- say 65 and over.

There are then two roughly equivalent ways of measuring the full impact of ΔPR on S(0). One consists in actually regressing r/w on ΔPR and on the proportion of adult men 65 and over, M65. The result of this regression, with r defined as retired men over 65, is:

$$(11) \qquad \frac{r}{w} = \underset{(13.93)}{-0.08} + \underset{(7.14)}{0.109\Delta PR} + \underset{(9.36)}{0.746M65}$$

The two independent variables are seen to account almost completely for r/w. Using (11) to substitute for r/w in (1.4), we find that the net coefficient of ΔPR in the savings equation becomes [0.35 - 0.61(0.109)] = 0.28.

The alternative consists in reestimating (I.4), modifying its specification by replacing the retirement ratio by the population composition variable, M65. It can be shown that this specification represents an alternative linear approximation to the non linear term ($\frac{W}{Z}\frac{r}{w}$) which appears in the right hand side of the non-linear equation (5a). The result of this alternative specification is:

$$(1.4'') \qquad \frac{S}{Y} = [1 - \underset{(2.47)}{0.40}\sigma(\text{Olsen}) - \underset{(2.37)}{0.81}n_1\sigma(\text{ILO})][\underset{(0.87)}{0.08} - \underset{(4.29)}{0.13}\frac{d}{w} - \underset{(1.27)}{0.50M65} + \underset{(2.54)}{0.26\Delta PR} + \underset{(5.24)}{2.70\rho}] \qquad S_e = 5.05$$

It can be seen that in (I.4") all the coefficients in common with (I.4) are very nearly the same except for that of ΔPR whose value (0.26) is appreciably smaller and is, instead, quite close to the value estimated above by substitution (0.28). One can thus estimate $\frac{dS(0)}{d\Delta PR}$ to be .26. Substituting in (10) this value and the values of α_o from equation (I.4) and of β_1 from (6.3), we can estimate the total effects, direct and indirect, of social security.

The results of this calculation are rather surprising. Though the estimate varies from country to country (as the right hand side of (10) depends on S(0)), it is not uniformly negative. On the contrary, it ranges from -0.05(Greece) to +0.08 (Ireland), and is positive for over half the countries (including incidentally the U.S., 0.033). At the sample mean the effect is negligible (an increase of 0.1 in replacement rate would increase the saving rate by 10 basis points). This unexpected result (at least for us) is accounted for by the fact that the estimated replacement effect (α_o in equation I.4) turned out lower than anticipated, while at the same time the estimated effects of retirement on saving (from I.4")) and of social security or retirement (β_1 in (5.3)) appear rather large.

As a rough check on these results, we have reestimated a reduced form obtained by replacing ΔPR in (I.4") by the variables appearing on the right hand side of (5.3). In practice that means dropping ΔPR and adding, instead, ln(y). Since social security then appears in both factors on the right hand side, a linear specification is easier to interpret. We, therefore, rely on the linear approximation comparable with equation (I.4'). The result is:

$$\text{(I.4")} \quad \frac{S}{Y} = \underset{(0.20)}{0.016\sigma(\text{Olsen})} - \underset{(0.10)}{0.01n_1\sigma(\text{ILO})} + \underset{(2.64)}{0.22} - \underset{(2.79)}{0.16\frac{d}{w}} - \underset{(0.64)}{0.26M65}$$

$$+ \underset{(0.56)}{0.02\ln(y)} + \underset{(4.01)}{2.14\rho} \qquad S_e = 6.50$$

The coefficients of social security are seen to be of negligible magnitude and insignificant, providing striking confirmation that, on the average, the direct and indirect effects of social security pretty much cancel each other out. This result is also consistent with the conclusion reached by others who have estimated "reduced forms" analogous to (I.4").[19]

CONCLUSIONS

The results presented above provide strong support for the life cycle hypothesis. Estimates of the impact on the savings rate of income growth, demographic factors, and retirement span are quite close to those suggested by the LCH and are rather robust. The impact of social security, on the other hand, is harder to pin down. We have encountered difficulties in estimating reliably the replacement effect of social security; it is quite sensitive to specification of the non-social security variables and swayed by extreme observations in the sample. In addition, our best estimates of the direct replacement effect tend to be somewhat below our *a priori* expectations.

The indirect effect of social security on retirement, on the other hand, is unexpectedly large. The combination of the weak direct and strong indirect effects turns out to imply that, for most countries, the net impact of social security is close to zero, though possibly on the plus side. Thus, our results imply that there is little cause for concern that social security dramatically reduces the savings rate. On the other hand they do imply that the saving rate is maintained through a reduction of the working span and hence of income per capita, suggesting that a rise in social security may tend, after all, to reduce private per capita saving and wealth.[20]

APPENDIX A

In this appendix we list the data used in the savings and retirement equations. A key to the variable names is given below.

SR	The private savings ratio
REPC	The Olsen replacement rates (not adjusted for coverage)
SSBEN	Replacement rates calculated from ILO data
POP20	Ratio of population below 20 to population 20 and above
MW	Ratio of children under 15 to the male labor force
RETPOPADJ	Ratio of retired population above the minimum age of retirement (for social security purposes) to population 20 and above
RETMEN55	Ratio of retired men 55 and above to male labor force
RETMEN65	Ratio of retired men 65 and above to male labor force
ΔPR	(Labor force participation rate 25-54 - Participation rate 65 and over) / Participation rate 25 through 54
IGRO	Rate of growth (per year) of real per capita disposable income
ln(YWKNG)	Natural log of real GDP per worker ($1970 US)
W2NORM	The weights (normalized to sum to 1) assigned to each country by the GLS correction for heteroskedasticity

A more detailed description of the data, sources and approximation, may be found in the text.

APPENDIX B

	SR	REPC	SSBEN	POP20
AUSTRALIA	0.1475	NA	0.263381	0.6043
AUSTRIA	0.1613	0.67	0.472441	0.4398
BELGIUM	0.1602	NA	0.209567	0.434
CANADA	0.1184	0.42	0.251799	0.6874
DENMARK	0.098	0.51	0.346535	0.476
FINLAND	0.1564	NA	0.39819	0.5695
FRANCE	0.1529	0.65	0.236842	0.4865
GERMANY	0.1704	0.48	0.582465	0.4128
GREECE	0.1359	NA	0.363575	0.4916
IRELAND	0.1347	NA	0.219325	0.6585
ITALY	0.1744	0.6	0.271493	0.4707
JAPAN	0.2413	NA	0.039841	0.574
LUXEMBOURG	0.1349	NA	0.426205	0.397
NETHERLANDS	0.1921	0.5	0.571429	0.5846
NORWAY	0.128	0.38	0.428669	0.4849
PORTUGAL	0.114	NA	0.083501	0.5986
SPAIN	0.1494	NA	0.134021	0.5505
SWEDEN	0.098	0.44	0.402613	0.4091
SWITZERLAND	0.1775	0.45	0.354389	0.4414
UNITED KINGDOM	0.1002	0.36	0.346439	0.4398
UNITED STATES	0.103	0.44	0.272346	0.6127

	MW	RETPOPADJ	RETMEN55	RETMEN65
AUSTRALIA	0.966	0.1177	0.1072	0.0891
AUSTRIA	0.8771	0.2032	0.2241	0.168
BELGIUM	0.8521	0.2195	0.2232	0.1753
CANADA	1.1899	0.1112	0.1214	0.0993
DENMARK	0.7914	0.1616	0.1408	0.1219
FINLAND	1.012	0.1105	0.1191	0.0843
FRANCE	0.9104	0.1938	0.1753	0.1282
GERMANY	0.7659	0.1631	0.1616	0.1287
GREECE	0.9013	0.1488	0.1294	0.0931
IRELAND	1.0832	0.1304	0.1097	0.0946
ITALY	0.8761	0.221	0.1754	0.1221
JAPAN	0.9225	0.0753	0.0646	0.0473
LUXEMBOURG	0.7474	0.1992	0.2158	0.1474
NETHERLANDS	1.0315	0.1386	0.1616	0.1313
NORWAY	0.8793	0.1458	0.1919	0.1687
PORTUGAL	0.9526	0.0994	0.0681	0.0475
SPAIN	0.9299	0.1067	0.0935	0.0737
SWEDEN	0.7168	0.1684	0.1727	0.1471
SWITZERLAND	0.6986	0.1219	0.0956	0.0837
UNITED KINGDOM	0.7792	0.1755	0.1315	0.1219
UNITED STATES	1.106	0.1432	0.1386	0.1112

	ΔPR	IGRO	ln(YWKNG)	W2NORM
AUSTRALIA	0.7428	0.03036	1.89664	0.036332
AUSTRIA	0.8726	0.03714	1.52181	0.034611
BELGIUM	0.9091	0.03857	1.94517	0.026139
CANADA	0.7184	0.03492	2.16387	0.045182
DENMARK	0.713	0.02793	1.84829	0.020016
FINLAND	0.7223	0.04196	1.58667	0.0205
FRANCE	0.7623	0.04689	1.87897	0.07586
GERMANY	0.7804	0.03779	1.81697	0.105145
GREECE	0.5876	0.06346	1.20791	0.024672
IRELAND	0.5018	0.03492	1.47254	0.02435
ITALY	0.7984	0.05238	1.58366	0.101239
JAPAN	0.4546	0.07997	1.36002	0.070892
LUXEMBOURG	0.8291	0.0203	2.15622	0.003649
NETHERLANDS	0.8335	0.04637	1.99009	0.051273
NORWAY	0.6684	0.0383	1.93442	0.015477
PORTUGAL	0.4003	0.06453	0.872588	0.012915
SPAIN	0.5344	0.05475	1.35913	0.061056
SWEDEN	0.7571	0.02289	1.96963	0.022896
SWITZERLAND	0.6229	0.0294	1.81125	0.027201
UNITED KINGDOM	0.7687	0.00974	1.7818	0.050571
UNITED STATES	0.7061	0.03168	2.36049	0.170027

Footnotes

1. This formulation relies on the simplifying assumption that social security benefits are received only upon retirement, which is frequently but not unequivocally the case. It is adopted because it greatly simplifies the exposition without any essential loss.

2. In one potentially relevant case, however, the total effect would be exactly zero. It arises if a significant fraction of the population had no intention of retiring, and hence were not accumulating retirement wealth to begin with. The introduction of social security and forced "accumulation" through contributions may be expected to induce early retirement but again no private saving.

   It is also worth pointing out that there is a third channel through which the direct replacement effect is offset. That is, that σ may itself be a decreasing function of the retirement span, which arises when early retirement may only be taken at the cost of reduced benefits. Early retirement then reduces the replacement rate, and thus reduces the displacement of private saving.

3. For example, if the recipients differ in terms of average income, then n_1 would have to be reinterpreted as the share of aggregate income rather than of population accounted for by participants. The assumption that participants have the same length of retirement as non-participants, may also be questionable since social security should tend to lengthen retirement. If this assumption is dropped, one would have to add to the right hand side of (6) the term:

$$n_o n_1 \sigma \left(\frac{R_o - R_1}{\lambda L} \right)\left(1 + \lambda \frac{r}{w} + \lambda_d \frac{d}{w}\right)$$

   where R_1 and R_o are average expected retirement span of covered and non-covered households respectively.

4. See also the considerations in Footnote 2 above.

5. We must report, however, that some partial tests raise questions as to whether this hypothesis is fully consistent with our sample, with the conclusion clouded by (presumably chance) collinearity of the corporate saving rate and the social security variables.

6. The approximation abstracts from individuals who die before their planned age of retirement. The loss of these individuals reduces the population but not the labor force (since they would normally be retired) and thus increases the measured labor force participation rate of the older group, and biases downward our estimate of the expected length of retirement. Hopefully this bias may be roughly offset by individuals who live unexpectedly long after retirement.

7. In particular, the ratio $\frac{L}{Z}$ is invariant to equiproportional changes in L, D, and R.

8. One fairly general implication of the LCH bearing on this problem is that the introduction, or a major revamping, resulting in higher benefits to people who had not expected them at the start of their life cycle, should lead to a transient reduction in saving, larger than the steady state effect. Since the replacement rate of our sample countries was tending to rise, this transient effect may introduce an upward bias to our estimate of the replacement effect.

9. To the extent that retirement is not necessary to receive benefits, this measure is an underestimate of the eligible population. Since, however, not all non workers are truly eligible, this should be a reasonable measure.

10. Furthermore, we are able to use but one observation (for 1965) from Olsen's data.

11. There are two considerations pointing in this direction: (i) replacement is measured relative to income just prior to retirement, at which time earnings should be at their peak, and (ii) social security systems are often redistributive so that (well paid) men in manufacturing would have lower replacement rates relative to less-well-paid workers. On these grounds we would expect the estimates of column (3) to be somewhat smaller on average than those of colume (4), an inference which is not supported by the table.

12. Of course this procedure would not be efficient if the Olsen data contained no systematic information beyond that in the ILO data.

13. The weighting by population corresponds to the variance reducing force of a larger sample size, while weighting by the variance of the savings ratio is suggested by our conjecture that measuring the steady state savings ratio by the average ratio involves some error, the variance of which is greater if the actual savings rate is unstable. Though this weighting scheme is intuitively appealing, it has been pointed out to us that the two components are not independent.

The variance component actually has limited influence on the estimates. On the whole, weighting by population alone tends to improve the results noticeably. Those results inconsistent with the LCH became less significant, while those consistent with it became even stronger.

14. Though the determination of the savings rate and retirement habits are simultaneous endogenous decisions, it is unnecessary to use simultaneous equation estimation techniques (as Feldstein does) since the system of savings and retirement equations is recursive. For a discussion of the retirement equation, see Section IV.5.

One further problem may arise, however, in that the replacement rate might well be regarded as an endogenous variable, determined by the preferences of the country as expressed by the government. It is likely that interactions within the expanded system in which savings, retirement and social security benefits are simultaneously determined induce some correlation between the residual and the independent variables. Though we recognize that this problem may exist, we cannot forecast either its magnitude or direction, and have made no effort to correct for it.

15. To insure that the mixed measure results are not due merely to separation of the sample into two groups, we added a dummy to the first component of (T.3). The dummy was completely insignificant, though it did sharply reduce the significance of the social security measures.

16. One significant implication of the LCH, not stressed here, is that the savings ratio is independant of the level of income. This implication is easily tested by adding an income measure to the second component of (T.3). The income measure is described in detail in Section III.5.

    The results of such a test are clear. Income has no significant influence on the savings rate (the t-ratio is of the order of 0.1).

17. Another source of uncertainty regarding the effect of social security arises in the partial tests of the responsiveness of private saving to variation in its corporate saving component mentioned in footnote 5. Though the hypothesis that corporate saving is a perfect substitute for household saving does not receive very strong support, the addition of a corporate savings variable -- through its collinearity with the social security measures -- has the effect of reducing somewhat the magnitude and significance of the social security coefficients.

18. A case can be made for adding a dummy to (6.3), taking the value one for the 12 Olsen countries and zero otherwise. The results turn out to be rather disturbing -- the Olsen replacement variable as well as income coefficients become much smaller and insignificant. The reason seems to be that the Olsen countries have, on balance, a longer retirement and higher income, and apparently this effect can be caught by the dummy, with little additional information provided by income or social security.

    However, since the dummy is totally insignificant, we feel there is ground for rejecting the hypothesis that the longer retirement of the Olsen countries is due to some nondescript common factor, in favor of the hypothesis that it is instead related to the variables in (6.3). Nonetheless, these results must be taken as a warning that the coefficients of (6.3) may overstate at least the role of income.

19. It is, in particular, consistent with the studies of Gopits and Gotur [1979] and Barro and MacDonald [1978], neither of whom took into account a measure of retirement span. It is not consistant with Feldstein [1977, 1979], who finds the total effect to be significantly negative. In general, Feldstein finds a much stronger replacement effect than we do. The difference apparently results from the difference in periods studied and his reliance solely on the Olsen data.

20. Though our weak results with respect to the replacement effect of social security may be interpreted in support of Barro's [1974] "Ricardian" hypothesis that saving for bequests offset the government's social security program, we believe there is strong evidence this is not the case. First, the significant positive coefficient on income growth strongly suggests that individuals' planning horizons are finite. Second, in preliminary empirical work to be presented in a forthcoming paper, we find that adding a measure of the surplus of the social security system does not have the negative impact on the savings rate expected under Barro's hypothesis.

REFERENCES

Belsley, D., Kuh, E., Welsch, R., Regression Diagnostics: Identifying Influential Data and Sources of Collinearity, New York, Wiley, 1980.

Barro, R.J., "Are Government Bonds Net Worth?" Journal of Political Economy, 1974, Vol. 82, No. 6.

_____, and MacDonald, G.M., "Social Security and Consumer Spending in an International Cross-Section," Journal of Public Economics, Vol. 11, June 1979.

Dolde, W., and Tobin, J., "Mandatory Retirement Saving and Capital Formation," manuscript prepared for the IEA Conference on National Saving and Wealth, Bergamo, Italy, June 1980.

Eisner, R., "Social Security and Capital Accumulation," Northwestern University Mimeo, December 1980.

Feldstein, M., "Social Security, Induced Retirement, and Aggregate Accumulation," Journal of Political Economy, Vol. 82, No. 5, Sept.-Oct. 1974.

_____, "Social Security and Private Savings: International Evidence in an Extended Life-Cycle Model," in The Economics of Public Services, an I.E.A. conference volume, M. Feldstein and R. Inman, eds., 1977.

_____, "International Differences in Social Security and Saving," National Bureau of Economic Research Working Paper No. 355, May 1979.

Houthakker, H.S., "On Some Determinants of Saving in Developed and Underdeveloped Countries," in E.A.G. Robinson, Ed., Problems in Economic Development, Macmillan, London, 1965.

Hu, S.C., "Social Security, the Supply of Labor, and Capital Accumulation," American Economic Review, Vol. 69, No. 3, June 1979.

Hymans, S., "Saving, Investment, and Social Security," (forthcoming) National Tax Journal, March, 1981, Vol. 34, No. 1.

International Labor Organization, Cost of Social Security, Geneva, International Labor Organization, (various issues).

Kopits, G., and Gotur, P., "The Influence of Social Security on Household Savings: A Cross-Country Investigation," International Monetary Fund, Fiscal Affairs Department, August, 1979.

Leff, N., "Dependency Rates and Saving Rates," American Economic Review, December 1969.

Modigliani, Franco, "The Life Cycle Hypothesis of Saving and Intercountry Differences in the Saving Ratio," in Induction, Growth and Trade, Essays in Honour of Sir Roy Harrod, eds., W.A. Eltis, M. Fg. Scott, and J.N. Wolfe, Clarendon Press, Oxford, 1970.

_____, "The Life Cycle Hypothesis of Saving, the Demand for Wealth and the Supply of Capital," Social Research, Volume 33, No. 2, Summer 1966.

_____ and Brumberg, R., "Utility Analysis and the Consumption Function: An Attempt at Integration," in Post Keynesian Economics, edited by Kenneth Kurihara, Rutgers University Press, 1954.

_____ and _____, "Utility Analysis and Aggregate Consumption Functions: An Attempt at Integration," in The Collected Papers of Franco Modigliani, Volume 2, MIT Press, 1980.

Munnel, A., The Effect of Social Security on Personal Saving, Cambridge, Mass., Ballinger, 1974.

OECD, National Accounts of OECD Countries, 1960-1971, Paris, 1973

_____, Labor Force Statistics 1962-1973, Paris, 1975.

_____, Demographic Trends 1950-1990, Paris, 1979.

_____, National Accounts of OECD Countries, 1950-1978, Volume 1, Paris, 1980.

_____, Old Age Pension Schemes, Paris 1977.

Haanes-Olsen, L., "Earnings Replacement Rate of Old Age Benefits, 1965-75, Selected Countries," Social Security Bulletin (January), Vol. 41, No. 1, 1978.

Reimers, C., "Is the Average Age at Retirement Changing," Journal of the American Statistical Association, September, Vol. 71, No. 355, 1976.

Summers, R., Kravis, I.B., Heston, A., "International Comparisons of Real Product and its Composition: 1950-1977," The Review of Income and Wealth," Series 26, No. 1, March 1980.