# Market Imperfection and Life-Cycle Savings:
## An Empirical Note

Ganti Subralmanyam*

## I. Introduction

Why do people save? The answer is partly for emergencies and retirement and probably for power and bequests too. Sometimes absent minded saving also takes place. Can the aggregate saving rate generated by these motives sustain the desired rate of capital formation in a free enterprise economy such as that of the U.S.? The answer to this question was partly given a quarter centrury ago in a seminal paper by Franco Modigliani and Richard Brumberg (hereafter MB). The answer has since become a well-established model of personal consumption and savings called the Life Cycle Hypothesis (hereafter LCH). The life cycle model provides the crucial link between the microeconomics of household consumption behavior and the macroeconomics of aggregate saving behavior. Employing the U.S. data, MB have shown with a simple model how a household allocates its life resources to consumption over the life cycle such that rates of saving could be generated very close to those observed in the U.S.

To many researchers, however, it seems an accidental coincidence that the MB model came out with such a close prediction of the U.S. saving rate.[1] Furthermore, the central idea of the

* The author is Professor of Economics, National Institute of Bank Management, Bombay, India. He would like to thank his teachers at SUNY, Buffalo for useful comments and Mr. B.P.R. Vithal (Fiscal Adviser, Government of Sudan) for encouragement.

1 For details, see Russel (1974, 1978), White (1978), and Kotlikoff and Summers (1981).

model — that the lifetime pattern of consumption is independent of the lifetime pattern of earnings — cannot be true in a world filled with uncertainty, capital market constraints and intergenerational transfers of wealth (inheritances). It has been theoretically shown by Crawford and Lilien (1981) that any departure from the perfect capital markets and perfect foresight assumptions does have a systematic effect upon individual decisions relating to saving. Existence of uncertainty influences individual decisions to save via the "income" and "substitution" effects of social insurance. Kotlikoff and Summers (1981) have shown convincing evidence that intergenerational transfers of wealth are the prime determinant of aggregate capital accumulation in the United States.

It is typically the case in social sciences that theory tries to discover interesting hypotheses, while empirical research attempts to verify them. Recently in an interesting extension of the MB formulation, Russell (1978) examined the policy implications of three variants of the MB model of life-time income and consumption. In a utility maximizing framework he investigated the response of the steady state aggregate saving ratio to changes in various real world expectational and institutional constraints. The policy implications of manipulating these constraints are immensely important and interesting in terms of generating and sustaining desired rates of accumulation. The purpose of this note is to report an empirical test of the policy implications of Russell's theoretical inferences on life-cycle saving behavior.

The rest of the paper is organized as follows: Section II explains the model and the data problems and Section III presents the regression results and summary and concluding remarks.

## II. The Model and the Data Problem

The crucial points of the MB hypothesis are: i) An individual plans to consume all his wealth at an even rate throughout the balance of his life implying that he neither does inherit nor intends to bequeath any wealth and ii) the individual has imperfect foreknowledge of his future income stream, thus periodically planning his consumption using whatever new information is available each year.

Russell (1978) finds that the predictive power of the MB model has proved sensitive to changes in these assumptions. Consequently he reformulates the model of life-cycle planning and utility maximization into three models with (i) perfect foresight and perfect capital markets, (ii) perfect foresight but imperfect capital markets (constraints on consumer borrowing) and (iii) imperfect foresight regarding the future income stream.

A comparison of the three models yields the following functional relation of policy importance:

(1) $S^* = f(d, h, e)$

where $S^*$ = steady state savings ratio
d = household debt-income ratio
h = household inheritance-income ratio
e = elasticity of marginal utility of consumption with respect to income.

In the original MB model, with stationary population and zero productivity growth, $S^*$ is independent of d, h and e. In the real world context of positive productivity and population growth rates, inheritances, imperfect foresight and capital market constraints, the steady state savings ratio responds to changes in these policy variables as explained below.

A household willing to spend more than its current income but prevented from doing so by the borrowing constraints of imperfect capital markets is likely to reduce its life income potential and saving. In the absence of borrowing constraints, the relevant budget constraint of the household will be its "life resources" and this is likely to enhance its earnings and savings potential. Thus if $S^*$ is the optimal savings ratio when the value of the capital market constraint is 'd', then[2]

$$\frac{\partial S^*}{\partial d} < 0$$

[2] For proofs, see Russel (1978).

A higher ratio of inheritances to income makes the household lower uniformly the consumption-earnings ratio in order to bequeath more. In other words, a higher inheritance-income ratio is likely to raise the savings ratio. Thus if S* is the savings ratio when the value of the inheritance-income ratio is 'h', then[3]

$$\frac{\partial S^*}{\partial h} > 0$$

Finally, if S* is the savings ratio when the income elasticity of the marginal utility of consumption is 'e', then $\partial S^*/\partial e < 0$[4]. Thus the expected signs of parials 'S*' with respect to the policy variables are:

$$(2) \quad \frac{\partial S^*}{\partial d} < 0 \; ; \; \frac{\partial S^*}{\partial h} > 0 \; ; \; \frac{\partial S^*}{\partial e} < 0$$

The final specification of the savings function used here is an extended version of equation (1). The modification involves, following Swamy (1968), the addition of a fourth variable, that is, personal (disposable) income growth rate $g_1$ ($g_2$) on the right hand side of (1). This $g_1$ ($g_2$) serves as a proxy for all factors other than the three policy variables of this study. The sign of the partial of savings ratio with respect to $g_1$ ($g_2$) is expected to be positive.

Two methodological comments are in order here. The first one relates to the functional form used to approximate the savings function (1). It is sometimes held that the savings ratio is non-linearly related to its determinents. However, Feldstein (1976) has argued that a nonlinear form for the savings function is itself an approximation and a linear specification in estimation appropriately eliminates further arbitrariness. The second comment relates to the problem of simultaneity bias in single equation estimation of the savings function. Modigliani (1965) has shown that a simultaneous method has yielded about the same results as did the least squares technique. He (1970) has further shown that the simultaneity bias of savings ratio with the contemporaneous

[3] *Ibid.*
[4] *Ibid.*

growth rate of income is also a less serious problem. Thus, the final version of equation (1) used in estimation is:

$$(3) \qquad S^* = a_0 + a_1 d + a_2 h + a_3 e + a_4 g; \;\; g = g_1 \text{ or } g_2$$

where $a_1 < 0$, $a_2 > 0$, $a_3 < 0$, and $a_4 > 0$ are the theoretically expected signs of the coefficients.

Assuming that errors in optimization cause S* to deviate from the actual saving ratio S, we append an additive error term and estimate (3) for the United States economy. Initially, a seemingly uncommon data problem appeared for a while in that no time-series on 'e' ever could be compiled by any statistical organization. Empirical studies generally do not face ths problem. Weiserbs (1974), however, showed a way out of this problem. Estimating complete systems of dynamic demand functions for the Additive Quadratic Model (AQM) and the Linear Expenditure System (LES) for the United States, Weiserbs (1974) generated time-series of 'e' for both models for the period 1929-1972. While the LES model produced a well-behaved series, the AQM model yielded a defective series whose time shape moved in the wrong direction. The absolute values of 'e' for the AQM model increased overtime, thus apparently contradicting the non-satiation-of-preferences assumption of the classical utility theory. In the LES (actually Extended Linear Expenditure System) model, 'e' is ingrained in the very definition of saving ratio and as such it cannot be used directly as an independent variable determining savings ratio.[5] Therefore, the least squares procedure was used to derive the theoretically appropriate 'e' series as follows: The LES derived 'e' series of Weiserbs is first regressed on the strictly exogenous variables of the system such as government purchases of durables, nondurables, labor services, real exports of durables, nondurables, U.S. population etc., to purge 'e' of the error term.[6] Next, employing the estimated regression relation, values of 'e' are predicted. It is these predicted values, which are used as the theoretically appropriate time-series in the estimation of savings function (3).

[5] For details, see Lluch and Williams (1975).

[6] Time series on the exogenous variables are taken from Berndt and Christensen (1973) and are further extended by the author up to the year 1972.

For the time-series on 'd' we used the ratio of consumer credit to personal (disposable) income. The variable 'h' is measured by the ratio of social security wealth to personal (disposable) income. The ideal choice of time-series on consumer inheritance would be data on taxable value of estates and gifts. Unfortunately, unavailability of continual time-series data on estates and gifts constrained us to use social security wealth as a proxy since the social security system is probably the biggest program of intergenerational transfers of wealth in the U.S. illustrating the usefulness of the life-cycle perspective. Social security welath estimates by Barro reproduced in Bukhauser and Turner (1978) are used for inheritance data in this study. Personal saving and income data are taken from the National and Product Accounts of the U.S. Data on consumer credit are taken from the various issues of the Federal Reserve Bulletin.

## III. Regression Results and Concluding Remarks

Estimate regression results of (3) are presented in a Table below. It is highly interesting to note that all the ocefficients have the expected signs. For completeness, we experimented with two measures of the dependent variable: (i) personal savings-personal income ratio ($S_1$) and (ii) personal savings-personal disposable income ratio ($S_2$). The t-values of the coefficient estimates indicate that all the three policy variables along with the growth variable are significant at better than conventional levels of confidence. The Durbin-Watson values indicate the absence of auto-correlation of errors. Thus, the parameter estimates of the savings function are statistically efficient too. The fact that $\bar{R}^2$ is greater than 0.5 in both the regressions seems to indicate that these policy variables have significant influence on the life-cycle savings decisions of households and hence on the aggregate savings ratio.

The signs of the estimated regression coefficients verifyingly agree with the theory. Each coefficient is of a reasonable order of magnitude. A one percent equivalent of increase in 'd' and 'e' respectively causes about 0.65 and 0.25 percent reduction in savings ratio. Similarly, a one percent rise in the personal (disposable) income growth rate raises the savings ratio by about 0.3 percent and the desire to bequeath more, say, by way of one

## Table 1

TWO – PASS LEAST SQUARES RESULTS OF THE SAVINGS FUNCTION

| Independent Variables and Summary Statistics | $S_1$ | $S_2$ |
|---|---|---|
| d | – .678 | – .648 |
| | (–4.78) | (–4.31) |
| h | 2.08 | 1.92 |
| | ( 2.18) | (2.85) |
| e | – .240 | – .278 |
| | (–2.36) | (–2.58) |
| g | .277 | .299 |
| | (4.25) | (3.92) |
| constant | .435 | .492 |
| | (2.78) | (2.96) |
| $\bar{R}^2$ | .562 | .564 |
| DW | 1.66 | 1.68 |
| F(4, 36) | 13.83 | 13.96 |

Note: Numbers in parentheses are t values. $S_1$ is personal savings-personal income ratio, and $S_2$ is personal savings-personal disposable income ratio.

percent increase in 'h' is likely to raise the savings ratio by almost two percent. This may be due to the presence of precautionary and power motives also whose influence it is difficult to disentangle from that of bequest motive. Unlike in Feldstein (1976) study, a positive coefficient of the social security wealth (proxy for bequests) rightly agrees with the recent findings by Kotlikoff (1979). The empirical findings of this study apparently indicate that Russell's reformulation of the simple form of life-cycle theory provides a more realistic framework for explaining the saving behavior of households.

In conclusion, it is interesting to note that in the life-cycle framework a government policy designed to influence the three policy variables is likely to alter the household's lifetime budget constraint and hence the pattern of saving and accumulation of saving in the desired direction.

## References


Berndt, Ernst R. and Laurits R Christensen, "The Translog function and the Substitution of Equipment, Structures and Labor in U.S. Manufacturing 1929-68," *Journal of Econometrics,* 1, March 1973, pp. 81-114.

Burkhauser, R.V. and J.A. Turner, "A Time-Series Analysis on Social Security and its Effects on the Marketwork of Men at Younger Ages," *Journal of Political Economy,* 86, August 1978, pp. 701-725.

Crawford, Vincent P. and David M. Lilien, "Social Security and Retirement Decision," *Quarterly Journal of Economics,* 96, August 1981, pp. 505-529.

Farrell, A. J., "The Magnitude of Rate of Growth Effects on Aggregate Savings," *Economic Journal,* 80, December 1970, pp. 873-894.

Feldstein, Martin S., "Social Security and Private Savings: International Evidence in an Extended Life–Cycle Model," In Martin Feldstein and Robert Inman (eds), *The Economics of Public Services,* Macmillan, London, 1976.

Kotlikoff, Lawrence, "Testing the Theory of Social Security and Lifetime Accumulation," *American Economic Review,* 69, June 1979, pp. 396-410.

Kotlikoff, Lawrence J., and Lawrence H. Summers, "The Rate of Intergenerational Transfers in Aggregate Capital Accumulation," *Journal of Political Economy,* 89, August 1981, pp. 706-732.

Lluch, Constantino and R. Williams, "Cross-Country Demand and Savings Patterns: An Application of the Extended Linear Expenditure System," *Review of Economics and Statistics,* 57, 1975.

Modigliani, Franco, "The Life-cycle Hypothesis of Saving-Part III," referenced in Swamy, 1968.

———, "The Life–cycle Hypothesis of Savings and Intercountry Differences in the Savings Ratio," in W.A. Eltisetal (eds), *Induction, Growth and Trade Essays in Honour of Sir Roy Harrod,* Clarendon Press, Oxford, 1970.

Russell, Thomas, "The Effect of Improvement in the Consumer Loan Market," *Journal of Economic Theory,* November 1974, pp. 327-339.

———, "Rate of Growth Effects on Aggregate Savings: Further Analysis," *Review of Economic Studies,* February 1978, pp. 153-168.

Swamy, Subramanian, "A Dynamic Personal Savings Function and its Long-run Implications," *Review of Economics and Statistics,* 50, February 1968, pp. 111-116.

Weiserbs, Daniel, "More About Dynamic Demand Systems," *Recherches Economiques de Louvain,* 40, 1974, pp. 33-42.

White, Betsy B., "Empirical Tests of the Life—Cycle Hypothesis," *American Economic Review,* 68, September 1978, pp. 547-560.