LIFE CYCLE MODEL OF ACCUMULATION ON TRIAL: AN ECLECTIC SURVEY

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Abstract

In this review essay, the successes and failures of the life cycle model of wealth accumulation at macro and micro levels are evaluated. The model is contrasted with the competing intergenerational model of wealth accumulation. Failure of the life cycle model to explain wealth accumulation (and decumulation) for most micro empirical studies will lead to the conclusion that heterogeneity of population cannot be ignored in economic modeling. This conclusion casts doubts about the usefulness of macroeconomic modeling with a single optimizing agent.

Introduction

Two decades before optimizing microeconomic models of rational expectations and job search became fashionable in macroeconomics, the microeconomic life cycle model of saving and accumulation was introduced [47]. The life cycle model is the prototype or microfoundation of macroeconomics. Few theories have enjoyed such popularity and approval. The model explains economic growth and the level of wealth in an economy. It offers a simple story of a representative consumer or household. A consumer begins life with little. He or she saves a fraction of yearly income. This leads to increases in assets held by the consumer until he or she retires. After retirement, the consumer starts to decumulate wealth. At death, little wealth is left behind.

This view of saving and wealth accumulation contrasts with Marshall [39] a generation earlier: "That men labour and save chiefly for the sake of their families and not for themselves is shown by the fact that they seldom spend after they have retired from work more than the income that comes from their savings, preferring to leave their stored wealth intact for their families". Thus, the life cycle

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model shifted the motive for saving and accumulation from intergenerational transfer to the desire to fund consumption during retirement. In recent years, Marshall's view of accumulation has been resurrected after a critical reexamination of the life cycle model (see [14]).

Two points are worth noting. A recent study by King [30] provides an extensive survey of the economics of saving. King distinguishes two types of models, myopic Keynesian models and forward looking life cycle models. According to his definition, any model where individuals plan for future consumption streams qualifies as a life cycle model. He does not distinguish a model where individuals do not have any bequest motive from a model where individuals have bequest motives. This approach is unsatisfactory (for example, adding a bequest in the utility function implies that the model treats bequest and charitable giving symmetrically). The current debate (with serious policy implications about the impacts of the social security and government debt on the capital stock) revolves around the question of whether a model without bequest (life cycle model) or a model with bequest (intergenerational model) better represents real world observations. Kurz [36] criticizes King. He writes "this debate [between the life cycle and the intergenerational models] received no treatment in King's exposition."

The literature dealing with life cycle models of income is not reviewed in this paper. In some parts of the literature, there has not been a clear distinction between the life cycle model of saving and accumulation and the life cycle model of income. The latter deals with the earnings of individuals over life cycles. Both of these topics have been treated as life cycle models of consumer behavior. For example, the bibliography by Mann [38] seems to ignore the distinction. Life cycle income obviously affects life cycle wealth. But the underlying issues debated are not the same. An excellent in-depth analysis of the life cycle model of income and its relationship with consumer behavior can be found in Deaton [17].

Early Tests of the Life Cycle Model

It is instructive to review how the life cycle model arose and how it was tested by early researchers. Until the early 1940s, economists were influenced by the Marshallian view. Economists, however, did not have the data to test Marshall's hypothesis. Harrod [25] first suggested that saving could done for later dissaving. Harrod argues that the most important reason for wealth accumulation is old age consumption. Harrod's argument is formalized by Modigliani and Brumberg [47]. Two crucial implications of the model are that an economy can accumulate a large stock of wealth (relative to income), even when no wealth is transferred through bequests; and the wealth income ratio and saving rate are determined predominantly by the length of retirement. (See Modigliani [45] for implications of this version of the life cycle model.)

The life cycle model can be tested in a number of ways. Early tests were crude. One method entails asking individuals why they save. Another method examines the result of behavior of individuals (age-wealth profiles) and checks whether it is consistent with the life cycle model. Each of these methods is discussed below.

In survey questionnaires, the respondents are asked why they save. A typical example of this method is reported in Projector and Weiss [49]. Among the respondents, 41 percent cite old age consumption, 32 percent list emergencies, and only 3 percent cite provision for an estate for family as a reason for saving during working years. This evidence seems to support the life cycle model. Subsequent questionnaire studies of representative samples have been criticized by researchers for overrepresentation of younger individuals in the population. It is argued that the relevant target group should be mature men and women. In 1971, the **National Longitudinal Survey** of mature men asked the following question: "Some people would like to leave an inheritance to their children, others believe that once the children leave home, parents have no further obligation. How do you feel about this?"

Three possible responses and the percentage of responses are given below:

1. Want to leave an inheritance (66 percent);
2. No further obligation (24 percent); and
3. Don't know (10 percent).

This response is incongruent with the Projector and Weiss study. It also should be noted, however, that the formulation of the question in the two surveys was not identical. Given the personal nature of these questions, there is room to doubt the validity of such studies.

A second test of the life cycle model is to examine the age-wealth profiles of consumers. Specifically, one implication of Harrod's hypothesis is the hump-shaped age-wealth profile of a typical consumer: If a consumer saves part of his or her income every year before retirement, then the consumer's wealth will increase with age. After retirement, if the consumer dissaves, the amount of wealth will decline with age. Therefore, the age-wealth profile of the consumer will have a hump (or an inverted U-shape), as indicated in Figure 1. On average, the number of working years is twice as long as the number of years in retirement. Therefore, the decumulation is expected to be rapid relative to accumulation.

This pattern was observed for cross-section data in the early 1950s by the **Oxford Savings Survey** [46] and in cross-section U.S. data where the value of the liquid assets is used as a proxy of wealth [22]. These studies were based on cross-section data to obtain the hump shape. The life cycle model implies a hump-shaped age-wealth profile of the representative consumer over the consumer's lifetime. An interesting question arises: Does a hump-shaped cross-section age-wealth profile provide sufficient evidence that the life cycle model is true? The answer is negative. Shorrocks [50] shows that for the life cycle model to be valid, it is necessary to have hump-shaped cross-section age-wealth profile, but it is not sufficient.

With recent data, however, the life cycle model seems to fail this simple test when the data are stratified to control for other variables. Mirer [41, 42] shows, using a sample of 2713 couples, that the age-wealth relationship has a positive slope everywhere, no matter what the age of the consumer is, if a control variable for the level of education is used. This new evidence seems to destroy the simple picture of the consumer depicted in Figure 1. More recent studies criticize Mirer's approach. A subtle reason has been suggested by Bernheim [9]. He argues that the notion of wealth used in the study by Mirer is faulty. In particular, a retired person's wealth is not just the sum of all the assets owned, but wealth must include the expected Social Security benefits, expected Medicare support, private pensions, and any other asset that an individual can consume contingent on survival. According to this view, the wealth of a person at a given point in time consists of two components: Bequeathable wealth and nonbequeathable wealth. Mirer fails to take into account nonbequeathable wealth.

Bernheim demonstrates the difficulty that arises when the nonbequeathable component of the wealth figure that is not paid in a lump sum at the beginning of retirement is added. The future payments must be evaluated at some discount rate. The future value of the wealth can be small if the discount rate is assumed to be large. How should the discount rate be determined? The interest rate and the mortality rate affect the valuation of the nonbequeathable wealth because an individual must survive in order to receive benefits from the pension/Social Security system. Future mortality rates and future inflation rates play major roles in the valuation of the wealth of the elderly. Because future mortality rates and future inflation rates are not known, the current value of the assets of the elderly becomes uncertain. Bernheim shows that the age-wealth profile is sensitive to the discount rate used.

If uncertainty is introduced in the life cycle model (uncertainty about the length of life or uncertainty about the future interest/inflation rate), testing the life cycle model by studying the age-wealth profile becomes complicated. The value of nonbequeathable wealth depends on the perception of the individual about the discount rate. Bernheim shows that if nonbequeathable wealth is discounted with a mortality factor, the life cycle model prediction of a hump-shaped age-wealth profile holds.

Most age-wealth profile studies have used post-war U.S.data. Some researchers have studied the age-wealth profile using household data from other countries. For example, King and Dicks-Mireaux [31] use Canadian household data for 12,734 families in a 1977 survey.

They find a hump-shaped profile for asset holding over the life cycle, even for assets excluding rights to pensions and Social Security payments. Masson [40] uses the French cross-section surveys by INSEE for a number of years to construct a synthetic cohort data base. He finds a double-humped age-wealth profile. Ando's [2] data come from a Japanese household survey of approximately 90,000 households in 1979. He finds a rough confirmation of the age-wealth profile predicted by the life cycle model. Kearl and Pope [28] use historical records of nineteenth century Utah to study the age-wealth profile. These studies seem to favor the life cycle model when the concept of wealth is defined carefully.

What is a Life Cycle Model?

More sophisticated tests require a precise definition of the life cycle model. Similar to the quantity theory of money, there is no consensus view about the definition. To facilitate discussion, a technical definition of the life cycle model is presented.

Consider a representative consumer at time 1 maximizing the following (intertemporal) utility function:

$$(1) \quad E_1 u(c_1, c_2)$$

where E_1 is the expectation operator conditional on the information available at time 1 (about time 2), c_i is the consumption at time i, (i = 1, 2) and u is a von-Neumann Morgenstern utility function. The budget constraint depends on the information available at time 1:

$$(2) \quad c_1 + c_2/R = y_1 + y_2/R$$

where

y_1 = period 1 income of the consumer;

y_2 = period 2 income; and

R = gross rate of return on the investment in period 1.

A strong life cycle model is defined by the absence of any uncertainty in equation (1).

A weak life cycle model is characterized by the presence only of uncertainty regarding the length of life of the individual in equation (1).

Early researchers advocated the strong life cycle model. For example, Modigliani and Brumberg [47] contend "the phenomenon of uncertainty can be neglected without seriously affecting the usefulness of the analysis". This view has gone unchallenged for nearly 25 years. There were some attempts to influence this view, including Guthrie [24]. His study was based on hypothetical questions to 168 respondents. It suffered from the proverbial question of the economists--would a person really do what he or she says? Moreover, his data are biased because college students were used for the study.

In this paper's definition of the life cycle model, it is assumed that there is no motive for bequest. For the strong life cycle model, bequest is always zero. But bequests can arise in the weak life cycle model through accidental death. Theoretical implications of accidental bequest of wealth distribution are studied by Bevan and Stiglitz [7] and by Eckstein et al. [18]. They point out that whether there is accidental bequest in the weak life cycle model depends on the assumption of the markets for annuities [53]. If there is no market for annuities, there will be accidental bequests; otherwise, there will be none. In reality, such markets for annuities rarely are active in the U.S. (compared with the market for life insurance). Friedman and Warshawasky [23] present some intriguing simulation results indicating why such markets are not common in the U.S.

In view of Mirer's study, some researchers have abandoned the strong life cycle model and embraced the weak life cycle model (where the only uncertainty in the model arises from the uncertainty of the length of life of the individual). For example, Davies [15] shows in such a model of uncertainty that data on income and survival in Canada are consistent with the model. His results are based on the following assumptions: (1) the rate of return (r) on the assets is 3 percent; (2) the subjective rate of discount is below r; (3) the available annuities are dominated (in terms of rates of return) by (ordinary) saving.

In intergenerational transfer models, one source of utility of one generation is the utility of the following generation. Parents care for their children selflessly. On the other hand, bequests in a life cycle model can arise only from accidents or from capital market imperfections. Bernheim et al. [9] propose a model where the parents use a bequest as a strategy for attention from the children. If a bequest is used as a strategy, the implications regarding the effects of Social Security tax do not correspond to those of the intergenerational transfer model. Therefore, policy implications can be complex in Bernheim's model.

Unfortunately, the econometric evidence presented by Bernheim only weakly supports the hypothesis of the strategic bequest. Using **Longitudinal Retirement History Survey** data with 2,555 observations, Bernheim uses the number of visits or telephone calls per week by the children (V) as a proxy for attention. They estimate an equation regressing V on the bequest per child. Controlling for a number of other variables (such as health, etc.), Bernheim finds the coefficient for bequest per child to be statistically significant. The signs of some of the control variables are not those intuitively expected. Bernheim blames such problems on specification errors. In addition to the errors in measuring the attention variable, there are other problems in modelling bequest as a strategy by parents. For example, if parents have only one child, the threat of disinheritance may not be credible. More importantly, the number of children is an endogenous variable in the context of lifetime decision-making by parents. Thus, with a population in the U.S. where more and more couples have one child, the model seems to predict that per capita (strategic) bequests would decline. But, this is not the case.

The definitions of this paper do not reflect a consensus view of the life cycle model. Some researchers using the utility function $u(c_1, c_2, b)$ in place of equation (1), where b is the bequest of the individual to the offspring, call it a life cycle model. For example, Blinder et al. [10] use bequests in the utility function to derive optimal plans for consumption and bequests for consumers. A similar model which also includes uncertainty regarding the length of life has been used by King [30]. But incorporation of bequest in the utility function runs against the spirit of the life cycle model.

Inclusion of bequests in the utility function raises a number of questions: How is b determined in the model? Why does an individual care about the bequest and not the utility of the bequest that the offspring receive [35]? Is a bequest for an offspring different from a charitable contribution? Bequests and charitable contributions cannot be distinguished in the utility function. It makes more sense to include utility of the recipient in the utility function of the donor--the utility function of an individual, however, becomes dependent on the utility functions of all subsequent generations [5, 6]. Thus, with an operative bequest motive, the life cycle model becomes indistinguishable from the intergenerational model and it loses simplicity and tractability. More importantly, there are several implications of the life cycle model altered by the intergenerational model. For example, an intergenerational tax (such as a pay-as-you-go Social Security tax) in an intergenerational model has different implications than in the life cycle model in which there is no bequest motive.

Indirect Tests of the Life Cycle Model

There are several ways of testing the life cycle model: First, by studying the effect of fiscal policy in the model and comparing it with the data (specifically the Social Security tax/transfer scheme provides a unique opportunity for testing the life cycle model); second, by simulating the economy with a life cycle model and comparing it with the actual economy; and third, by comparing the actual wealth inequality with the wealth inequality generated by the life cycle model.

Consider the case of an economy that follows the strong life cycle model. If a pay-as-you-go Social Security system is introduced, a tax is levied on the current working population and the proceeds are transferred to the current retirees. Suppose that government promises the current workers that this process will continue when they retire. What effect will this Social Security system have on saving? For the saving of workers, it will produce a negative effect. Under the strong life cycle model, a one dollar increase in Social Security will produce a one dollar decline in saving. This is the so-called Feldstein displacement hypothesis. Estimating a time series saving function from aggregate data [3, 21] shows that a dollar increase in Social Security depresses saving in the U.S. by a dollar. In a subsequent study, Leimer and Lesnoy [37] show that Feldstein's original study contains a serious computational error. Professional consensus now seems to be that Feldstien's claim is not substantiated. Moreover, it has been argued [17] that the aggregate time series data do not contain adequate information to study the effect of Social Security on savings.

The introduction of Social Security in the weak life cycle model has different implications. Abel [1] shows that saving and wealth diminish by more than a dollar-per-dollar increase in the Social Security tax in the weak life cycle model. Hubbard [26] calculates the welfare loss in the steady state due to a Social Security tax in the weak life cycle model. The effects of Social Security for the life cycle model contrast with the implications of Social Security in the intergenerational model. In the intergenerational model, the central implication is that a Social Security tax of one dollar will induce individuals to increase their bequests by one dollar (because each individual cares for all subsequent generations). Thus an increase in Social Security tax will have no effect on saving and wealth accumulation.

It may seem that a rich set of household (micro-level) observations will be able to resolve questions concerning the validity of the life cycle model by testing the effect of a dollar increase in Social Security tax. Unfortunately, the evidence is mixed, i.e., a dollar increase in Social Security tax seems to decrease saving by less than a dollar (but more than zero). For example, Blinder, Gordon and Wise [10] find that a one dollar increase in Social Security tax reduces private saving by 39 cents. The standard error of estimate is large (despite the large sample from the **Longitudinal Retirement History Survey** of 4130 white men), and they were unable to reject the Feldstein displacement hypothesis. Mild support of the Feldstein displacement hypothesis is found by King and Dicks-Mireaux [31]. Other studies [35, 14] mildly refute the hypothesis.

This paper discusses only taxes in the life cycle model that explain the working of the model. Equity and efficiency aspects of different taxes on saving in a more general context (for example, tax on the interest accrued to saving) are discussed elsewhere [29, 32].

Another way to test the life cycle model is to simulate the economy and compare the resulting capital accumulation and wealth with actual figures. The first pioneering study was conducted by Tobin [54]. He assumes that individuals are not constrained to borrow to augment human capital. His data seem to support the model. Tobin crudely estimates crucial parameters such as the rate of return on capital, the rate of time preference, and the risk aversion factor. Later studies [11, 13, 56, 33] use more refined estimates of the parameters. These researchers use plausible parameter values in a strong life cycle model and calculate the capital stock. If the life cycle model were true, the calculated capital stock should be approximately the same as the observed capital stock. But the results differ. Further investigations show that the age-wealth profiles are too flat to generate sufficient life cycle wealth to explain the actual observations in the post-war United States.

More recently, the simulation studies have been criticized. For example, King and Dicks-Mireaux [31] argue that tight parameterization with isoelastic utility of consumption with the same elasticity parameter for every period and the separability of utility over time lead to the rejection of the life cycle model. White's model is replicated by Evans [19] to demonstrate that the choices of population and technology growth parameters are crucial; the model is not robust with respect to parameter choices.

There is another subtle reason why the life cycle model fails to explain the observed behavior of the population. There may be heterogeneity in the population.

Another way of indirectly testing the strong life cycle model is to study the wealth inequality in a given economy. This test cannot be applied easily to the weak life cycle model. In a stationary economy where the wage rate is not increasing over time, the only rich persons will be old if the life cycle model is correct. The only way to be rich is through saving over the life cycle. In an egalitarian society, there will be inequality in wealth among different individuals. Atkinson [4] provides a model for Great Britain to see what percentage of inequality can be explained. He shows that the strong life cycle model can account only for a small percentage. In his model, however, every individual is assumed to start working life with a given earning. In other words, there is no variation among individuals of a given age in terms of earning. It is conceivable that the variation in earning profiles account for large percentage of variation in wealth. Oulten [48] extends the Atkinson model to include variation in initial earning among individuals. Most of the variation in actual wealth still remains largely unexplained. Testing the life cycle model by studying wealth inequality applies only to the strong version. Testing the weak life cycle model using the wealth inequality is difficult. If uncertainty is admitted, some assumption must be made about the insurance available. If there is actuarially fair insurance available, the resulting model is similar to the certainty model. If uncertainty is assumed with no hedge against early death (in the case of the weak life cycle model, individuals prefer annuities over riskless bonds), then the life cycle model can produce some additional wealth inequality. What does the evidence show about the rate of return on annuities? Is it substantially worse than the rate of return on saving? To some extent, the result depends on the presence of a bequest motive of individuals. Friedman and Warshawasky [23] show by a series of simulation experiments that it is plausible even for individuals without bequest motives to account for low annuities purchases, given the observed rate of return on currently available annuities in the U.S.

Bevan and Stiglitz [7] show in a life cycle model without bequests where lifetime wage income of each generation is distributed lognormally that the wealth distribution in the steady state becomes skewed (wealth distribution becomes Pareto). This result is significant, according to Bevan and Stiglitz, because the observed wealth distribution of most western economies are Pareto (at least for income levels above some threshold value).

A study by Blinder, Gordon and Wise [10] of the life cycle model shows severe problems with identification and imprecise parameter estimates. Therefore, some researchers have abandoned the modeling approach. Varian [55] suggests ways in which consumer behavior can be studied econometrically using nonparametric methods. Hurd's [27] study using a nonparametric approach argues that there is no bequest motive of retirees if relevant variables are controlled. Using the **Retirement History Survey 1969-1979**, he compares four sets of households: (1) Retired couples without children; (2) Retired couples with children; (3) Retired singles with children; (4) Retired singles without children. He finds the wealth (excluding housing) decumulation rate of households with children is faster than that of households without children. This observation seems to hold for both retired singles and couples. He concludes that there is no bequest motive. He rejects the intergenerational model. He also shows that individuals dissave rapidly after retirement. He discredits earlier studies that found the average wealth increasing with age. He argues that those studies did not control for the retirement variable, i.e., they included all individuals regardless of employment status. Therefore, significant numbers included in the sample continue to work even after normal retirement age. These workers have masked the effect of dissaving by the rest of the population.

Conclusion

Testing the life cycle model with aggregate data is always suspect. Such data are confounded with business cycle effects. Modigliani's [43] pronouncement about the success of the life cycle model of accumulation, based largely on aggregate tests, is premature. Careful tests based on household data (preferably longitudinal) are needed.

This paper discusses empirical studies based on household data designed to test (directly or indirectly) the life cycle model (weak or strong). The results conflict. Differences in the results to some extent can be traced to differences in data sets used. Specifically, the data sets are not representative samples of the corresponding population--most data sets used were collected for other purposes. For example, the King and Dicks-Mireaux study has a larger fraction of poor consumers (relative to the whole population of Canada in 1971). Another example is Courant **et al.** who use **Panel Study of Income Dynamics** data that overrepresent nonwhite households, female-headed households, and low income households. Most other household studies are based on samples of older (and wealthier) segments of the population (for example, the **Longitudinal Retirement History Survey** seems to suffer from this bias).

Why does sample selection bias affect the resulting behavior? Is there a difference in the saving behavior in different segments of the population (does segmentation occur because of differences in age, income, educational level, etc.)? The answer seems to be affirmative.

Several studies confirm this answer.

Wolff [57] utilizes a specially created synthetic data set, the MESP data base. The data base consists of a cross-sectional sample of 63,451 households in the U.S. with demographic, income, and balance sheet information at the end of 1969. He investigates the validity of the strong life cycle model concerning the age-wealth relationship. He finds for wealth as a dependent variable that the explanatory power of age and age^2 is low for the whole population. The explanatory power rises markedly when the sample is restricted to white, urban, educated middle classes and when the form of accumulation is restricted to housing, durables, and money in banks. The model does not fit well for the rich or the poor.

On the other hand, the survey of Modigliani [44] concludes that "...these fairly consistent findings concur in suggesting a share of inherited wealth in total wealth below one fifth but probably above 15 percent..." Modigliani's view is disputed by Kotlikoff and Summers [34]. They accuse Modigliani of citing only evidence that suits the life cycle model, while ignoring other important work.

King and Dicks-Mireaux [31] mention that a segment of low income individuals seems to distort the hump shape of the age-wealth profile. These individuals have a severe budget constraint and do not save anything.

Table 1 is derived from the 1972-1973 **Consumer Expenditure Survey**. It seems that the source of the growth of wealth comes mainly from the top wealth holders.

In summary, the empirical evidence seems to indicate that:

The bottom 30 percent of the population is subject to so severe a budget constraint that its behavior appears to be myopic.

The middle class (40 percent of the population) conform to the strong life cycle model. The bottom 70 percent of the population's behavior can be explained in the weak life cycle model.

The top 30 percent of the population behaves more in accordance with the intergenerational model.

If these conclusions are true, researchers in the future must forsake modeling an economy by a representative consumer (see [51]). The heterogeneity among individuals with respect to their saving behavior must be recognized explicitly.

Finally, whether the economy can be modeled using a representative consumer has significant impacts for policy formation. For example, if the three class model holds, new issues of government bonds can be sold to the top wealth holders to finance expenditures on low income individuals without affecting capital formation in the economy. This assertion follows from the Ricardian equivalent theorem.

The life cycle model seems to be a good descriptive model for the bottom 70 percent of families (in income terms). It does not appear to be successful in modeling the behavior of 20-30 percent of the top wealth holding families (even though they appear to control most of the wealth in the economy).

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Table 1

Size Distribution of Change in Family Assets 1972-1973

Annual Income Range	Percentage of Units	Percentage of Total Increase in Assets
Less than $6,999	35	1
$7,000-$14,999	36	20
Above $15,000	29	79

[Source: Kurz (1985, p. 324, Table 2)]

Figure 1
Age-Wealth Profile of a Typical Consumer Under the Life Cycle Model of Saving and Wealth