An Investigation into the Effects of Population Aging on National Saving

by

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Peter J. Kasnisky, Dean of Graduate Studies
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ABSTRACT

In this paper, I investigate the determinants of the rate of national saving in the United States over the period from 1959 to 1999. My analysis focuses on the relationship between aggregate national income accounts data and demographic data. Specifically, I test whether or not current data supports the life-cycle hypothesis with respect to changes in the age structure of the population, measured by the dependency ratio, and find it to have a significant effect upon saving behavior. Additionally, income and the growth of income, wealth, the rate of interest, and life expectancy are also found to significantly influence saving behavior in the United States.
ACKNOWLEDGEMENTS

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Introduction

According to current projections, the United States and many other industrialized countries will experience a dramatic rise in the age of the population over the coming decades. "An American woman reaching child-bearing age in 1960 would expect 3.6 children; an identical woman in 1990 would expect only 1.9 children. That dramatic demographic change makes it almost inevitable that the American population will age rapidly over the next 50 years" (Cutler et al., 1). This marked decline in birth rates from the high levels in the post-WWII period along with improvements in mortality are the main causes for this shifting age structure. Such demographic changes have been accompanied by various macroeconomic changes. The question that I investigate in this paper is: Can these demographic changes be causally linked to changes in the macroeconomy, or more specifically, to the decline in the rate of national saving?

The progressive decline in the rate of net national saving1 in the United States has sparked increasing concern among many researchers. The rate at which "money" is saved out of national income declined steadily throughout the 1980s and has continued its downward trend in the 1990s (see Table 1 below). According to Bureau of the Census' population estimates, the age of the population in the United States has followed an upward trend during this same period. Furthermore, this trend is likely to continue over the next few decades as the "baby-boomer" generation begins to retire in increasingly larger numbers.

---

1 The net national saving rate is defined as real net national product minus real net national consumption (household consumption + government purchases) divided by real net national product.
Given the parallel changes in national saving and age structure of the U.S. population, can we determine any causal link between the two?

**Table 1. Average Annual Net National Saving Rates, 1960-1999**

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<tbody>
<tr>
<td></td>
<td>8.75%</td>
<td>8.52%</td>
<td>4.96%</td>
<td>2.34%</td>
</tr>
</tbody>
</table>

Source: Calculations based on NIPA data, Survey of Current Business (various issues).
* Through the second quarter of 1999.

Before investigating the possible relationship between the decline in the rate of national saving and shifts in the age structure of the population, it is useful to discuss the components of national saving. Specifically, national saving is the sum of private saving (personal saving plus corporate saving) and public saving (saving by federal, state, and local governments).

A visual analysis of private and public saving data allows us to look at the extent to which the decline in saving can be attributed to individual sectors. Both large federal deficits on the part of the public sector and increased levels of consumption in the private sector can be identified as culprits for the decline in national saving (see Table 2). A Congressional Budget Office study states that:

"According to the NIPA measure, federal deficits accounted for more than one-half of the decline in the net national saving rate between the 1970s and the 1980s. By contrast, state and local governments provided a boost to the national saving rate, mostly because many had surpluses in pension funds operated for their employees. Business and personal saving each accounted for about one-forth of the decline" (CBO, 4).
Table 2. Contributions to Net National Saving Rate

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Personal</td>
<td>4.7</td>
<td>5.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Business</td>
<td>3.5</td>
<td>2.6</td>
<td>1.6</td>
</tr>
<tr>
<td>State and Local</td>
<td>0</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Federal</td>
<td>-0.2</td>
<td>-1.7</td>
<td>-3.6</td>
</tr>
<tr>
<td>Natl.' Saving Rate</td>
<td>8.0</td>
<td>7.1</td>
<td>3.8</td>
</tr>
</tbody>
</table>


As Masson and Tryon (1990) point out, due to the aging of the population, it is probable that we will see a decline in the rate of saving in response to life cycle stimulus. In other words, “... individuals save for retirement during the years in which they are employed and dissave subsequently" (ibid., 454).

Accordingly, it can be implied that if current population projections hold, the United States may see an even further drop in the already low rate of national saving as the population ages even further.

The implications of further declines in the rate of national saving have caused this issue to be widely debated for a number of reasons. First, national saving provides the resources necessary to fund new capital formation which is needed to sustain economic growth in the United States. The substantial decline in the national saving rate over the past two decades, coupled with the possibility of further decline, raises questions regarding the United States' ability to sustain long-term economic growth in both production and standards of living.

Douglas Bernheim (1991) highlights these feelings in the following:

"The United States has become a nation of consumers. During the last decade, Americans maintained high standards of living in part by
neglecting the need to provide for their collective future. This cannot continue forever. Inadequate rates of saving have begun to threaten the very foundations of economic prosperity" (1).

The decline in private sector saving can be illustrated, in part, by looking at the trend in consumption expenditures as a percentage of national income, or GNP (see Table 3 below). Here we can see that consumption expenditures as a percentage of GNP have risen from 61.50% in the 1960s to 67.78% in the 1990s.

**Table 3. Consumption Expenditures as a Percentage of GNP, 1960-1999.**

<table>
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</thead>
<tbody>
<tr>
<td>Consumption</td>
<td>61.50%</td>
<td>61.95%</td>
<td>64.27%</td>
<td>67.78%</td>
</tr>
</tbody>
</table>

Source: Calculations based on NIPA Aggregate data, Bureau of Economic Analysis, Survey of Current Business (various issues)
Through the second quarter of 1999.

Increasingly lower rates of national saving have also given rise to concerns of future economic challenges that the country will encounter in the face of the retirement of the baby-boom generation – those born between about 1946 and 1964 as defined by the Congressional Budget Office. With the retirement of the “baby-boom” generation early in the 21st century, the United States will experience “an increasing number of elderly people dependent on a relatively diminishing working population” (Falkingham, 211). This factor is significant because according to the life-cycle hypothesis, a large number of retired individuals will act to depress national saving.

Feldstein (1980) notes that the life cycle theory implies that the rate of saving in a country will be higher with a large working age population relative to
the number of dependents – both retirees (in this paper, those ages 65 and older) and the young (those age 0 to 19 in this paper).

Many studies that are concerned with the relationship between saving and the age structure utilize dependency ratios to illustrate changes in the age of the population as a whole. Researchers have been concerned with both the elderly dependency ratio as well as the youth dependency ratio, with emphasis placed on the former. The justification for this line of thinking is that, in general, both the young and elderly are dissavers in the economy. Specifically, the young consume without contributing to production in the economy and the elderly dissave through the consumption of real and financial assets accumulated throughout their working lives.

Depending on the particular study, the actual definition of “young” and “elderly” may vary. In the most simple form, the elderly dependency ratio is the number of retirees to the number of persons in the labor force – or the ratio of those collecting public pension benefits to the labor force. Obviously, the manner in which “retirees” is defined leaves room for interpretation. For instance, the official retirement age may differ from one country to another. The same applies to definitions of the youth dependency ratio – usually defined as the number of youth dependents as a proportion of the labor force. The exact definition of “youth” may vary from study to study.

A cursory look at dependency ratios in the United States indicates an upward trend resulting from the aging of the population. In other words, there are increasingly larger numbers of retirees as a portion of the labor force as more
baby-boomers continue to retire. In the United States, the elderly dependency ratio has fallen from 5.1 (i.e., the inverse of the ratio as previously defined) workers per retiree in 1960 to the current level of 3.4 workers per retiree (see Table 4). And current projections call for an even further decline as the baby-boomers enter retirement in earnest. With the woes of our current pay-as-you-go retirement system (Social Security), this implies that the labor force will have to support an increasing number of retirees, thereby, putting an even greater strain on an already burdened system. Even with the scheduled increases in the retirement age in 2008 and 2026, the Social Security Administration forecasts indicate that the elderly dependency ratio will increase more than twofold (or fall by half, if defined as above) by 2050 (De Nardi et al., 1).

**Table 4.** Elderly Dependency Ratios

<table>
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<tbody>
<tr>
<td></td>
<td>.1831</td>
<td>.1919</td>
<td>.2096</td>
<td>.2169</td>
</tr>
</tbody>
</table>

* Through the third quarter of 1999.

Additionally, aging of the population in the United States is likely to affect the standard of living. Cutler et al. (1990) report: “We find that demographic changes unaccompanied by changes in capital intensity would reduce per capita incomes by between 7 percent and 12 percent over the next 60 years, but would actually increase incomes over the next 20 years” (2-3). In other words, baby-

---

2 The dependency ratio is the number of retirees who are entitled to social security benefits to the population of the labor force.
boomers will enjoy an increase in income, and standards of living, as they move towards retirement but their children and grandchildren are likely to experience a relative decline in the standard of living.

This paper tests the hypothesis that the decline in the rate of national saving that the United States has experienced over the past two decades is linked to the shift in the age structure of the population. NIPA aggregate national data, along with other demographic data, is used in a life cycle framework to investigate the effects of demographic changes in the United States, specifically changes in the age structure of the population, on the rate of net national saving (see footnote 1) from 1960 to present. Additionally, I will look at possible future implications concerning the rate of national saving if current population projections hold.
Chapter 1: Literature Review

The downward trend of the rate of national saving in the United States over the past two decades has inspired a great deal of research into its causes, as well as its macroeconomic and policy implications. Researchers, in the United States and abroad, have investigated the possible connection between declining saving rates and variables such as demographic changes (specifically population aging), changes in the consumption propensities among different age groups, changes in government spending, as well as others. Within the context of this paper, I will be concerned primarily with the discussion of how changes in the age structure of the population influences national saving.

Various studies have been conducted in attempts to determine the link between the decline in the rate of saving in the United States, as well as in other countries, and changes in the age structure of the population. It should be understood that population aging is a phenomenon not confined to the United States. Many other industrialized countries are experiencing (or will shortly begin to experience) similar aging patterns. Consequently, the macroeconomic effects of the decline in national saving and subsequent policy decisions that confront the United States are also of interest in several other industrialized countries facing similar circumstances.

Over the past two decades, the United States has seen a dramatic decline in the rate of net national saving (see Table 1). During this same period, the population has aged significantly as a large number of baby-boomers rapidly approach retirement age. According to current projections by the Population
Division of Bureau of the Census, the United States will experience significant aging over the first few decades of the new century. As a result of this aging, it is reasonable to expect a further decline in the level of saving if we consider the life-cycle motives for saving. In other words, a growing number of individuals who have been saving for retirement will essentially become dissavers as they enter retirement. This is important because “[A]n older population will consume more of aggregate disposable income...” (Masson and Tryon, 453), which will lower the level of saving. Additionally, the composition of government spending will change toward providing services to the elderly (i.e., increased medical expenditures) and away from expenditures on the shrinking (as a percentage of the total population) younger generation (i.e., education). Consequently, lower levels of employment resulting from contractions in the labor force brought about by declining birth rates will give rise to declines in output. “What happens to per capita output will depend on the resulting capital stock per worker, as well as on the proportion of the population in the labor force” (ibid., 454).

Several methods that have been used to investigate the economic effects of changes in the age structure of the population include MULTIMOD (the IMF’s multicountry econometric model), the Overlapping Generations Model, the Turnpike Model, and the Neoclassical Model. Discussions of some of these models used in actual studies are carried out next.

Masson and Tryon (1990) used MULTIMOD to simulate macroeconomic effects of population aging in a study of seven industrialized countries. They
used data from 1969 to 1987, pooled across the seven countries, and estimated
the following equation using ordinary least squares procedure:

$$
\Delta \log C = \text{country constants} + .113 \log(W_{t,t}/C_{t,t}) - .473 RLR + .408 \Delta \log YD
$$

(3.5) \hspace{1cm} (4.0) \hspace{1cm} (5.5)

$$
+ .124 \text{DEM3} + .032 \text{DEM3}\times \text{DUM80}
$$

(1.5) \hspace{1cm} (2.2) \hspace{1cm} R^2_{adj} = .641 \hspace{1cm} \text{SER} = .026

where the t-statistics appear in parenthesis, \( W \) is real wealth, \( C \) is real consumption expenditures, \( RLR \) is the real long term interest rate, \( YD \) is real, after-tax net domestic product, \( \text{DEM3} \) is the overall dependency ratio (the sum of the young dependency ratio and the elderly dependency ratio), and \( \text{DUM80} \) is a dummy variable set equal to 1 for years after 1980 (this was used to indicate a break or possible imperfection in census estimates).

According to their estimated equation, an increase in the dependency ratio, representing an increase in the age of the population, would result in an increase in consumption (and therefore a decrease in saving). However, one should be careful in interpreting this estimate’s actual meaning. Use of this “overall dependency” ratio, versus separate ratios for the youth and the elderly, results in a restriction on the model. By assuming that the overall ratio is the sum of the two independent ratios, the authors imply that the consumption propensities are the same for both groups. Although this is most likely not the case, a discussion of this is not within the context of this paper.

In order to see how saving is affected by changes in the age structure, it is necessary to convert this consumption function to a saving function. This will
allow a comparison of this estimation with the outcome of other studies as well. Since (the rate of) saving can be illustrated as the difference between income and consumption, or \( s = 1 - \frac{C}{Y} \), where \( s = \frac{S}{Y} \), Masson and Tryon (1990) indicate that "the saving rate responds to the dependency ratio in the long run (for a given real interest rate and wealth/income ratio)" in the following manner:

\[
\frac{ds}{dDEM3} = - \frac{d(C/Y)}{dDEM3} = - \frac{d \log C}{dDEM3} \frac{C}{Y} = \frac{(1.24 + 0.032)}{1.13} \frac{C}{Y} = (1.38) \frac{C}{Y}
\]

Here, a one-percent increase in the dependency ratio is associated with, on average, a 1.38-percent increase in consumption. In other words, as dependency increases via the aging of the population, the rate of saving will decline.

Another study concerned with the dynamics of an aging population used a general equilibrium Overlapping-Generations Model (Auerbach, 1989) of four countries – the United States, Japan, Germany, and Sweden. The findings of this particular model indicate that the rate of national saving is "... very sensitive to the forecast increases in dependency ratios" (6). Specifically, population aging will result in a decline in the rate of national saving in the United States, as well as in the other three countries included in the study. The authors indicate that, "Each country exhibits a decline in its national saving rate between 1960 and 1985, attributable to a movement of a relatively large cohort into the period of life when life-cycle dissaving occurs" (16). In the United States, it is during this period that large numbers of baby-boomers enter the labor force. The early stage of an individual’s working life is generally characterized by dissaving. Also
of interest during this period is the fact that labor force participation among older cohorts declined steadily.

In 1991, Charles Horioka developed a single equation model to analyze the relationship between the national saving rate and population aging in Japan. The estimation of this model (with t values in parentheses) is presented in Yashiro and Oishi (1997) as follows:

\[
\text{STOT}\% = 65.96 - 91.967^*\text{OLD} - 41.917^*\text{YOUNG} + .6364^*\text{GRGNPPC}\%(-1)
\]

\[
(12.20) \quad (-5.19) \quad (-7.25) \quad (6.07)
\]

\[R^2_{\text{adj}} = 0.688\quad D.W. = 1.092\]

where STOT% is the gross national saving rate, OLD is the elderly dependency ratio, YOUNG is the youth dependency ratio, and GRGNPPC% is the annual growth rate of real per capita GNP (lagged one period, as indicated in the model).

According to this estimation, there is a very significant effect of population aging, as indicated by the dependency ratios, on the rate of saving. One of the main conclusions that Horioka (1991) reaches is that:

“The age structure of the population is found to be the primary determinant of both trends over time in Japan’s saving rate and the high level thereof relative to the other developed countries, and the estimation results are found to imply that Japan’s saving rate will decline sharply due to the rapid increase in the ratio of the aged population to the working-age population” (238).
Presented below are four similar econometric models developed by various economists between 1970 and 1986 in an attempt to explain private saving behavior using a number of different variables. Since the goal of this paper is to investigate national saving and not just private saving, care must be taken in the comparison of these models with the model estimated in this paper. However, similarities exist in that the models all have foundations in the life-cycle hypothesis. The following econometric models of saving are presented in Heller (1989):

(a) The Modigliani Model (1970)

\[ s = 33.7 + 1.31(y) - 0.88(\text{AGE}) - 0.20(\text{DEP}) \]
\[ (0.3) \quad (0.28) \quad (0.054) \]
\[ R = 0.77 \quad \text{SEE} = 2.16 \quad \text{N} = 24 \]

(b) The Modigliani and Sterling Model (1980)

\[ s = 0.02 - 0.51(\text{AGE}) - 0.13(\text{DEP}) + 2.36(\text{GDY}) + 0.29(\text{CHPR}) \]
\[ (0.12) \quad (0.09) \quad (0.39) \quad (0.11) \]
\[ \text{SEE} = 4.67 \quad \text{N} = 21 \]

(c) The Feldstein Model (1980)

\[ s = 0.92 + 5.24(G) - 1.21(\text{AGE}) - 0.77(\text{DEP}) - 0.37(\text{B/E}) - 0.54(\text{LPAGED}) \]
\[ (1.33) \quad (0.45) \quad (0.20) \quad (0.13) \quad (0.27) \]
\[ R = .90 \quad \text{SEE} = .0182 \quad \text{N} = 12 \]
(d) The Horioka Model (1986)

\[
s = 1.38 - 0.33(\text{GYP\text{C}}) - 1.61(\text{AGE}) - 0.92(\text{DEP}) - 0.29(\text{LPAG\text{E}D}) \\
\quad (1.61) \quad (0.40) \quad (0.22) \quad (0.10) \\
+ 0.47(\text{INFL}) + 0.16(\text{GDP\text{D}EN}) - 0.0075(\text{RET\text{A}GE}) \\
\quad (0.16) \quad (0.10\text{E}^{-4}) \quad (0.003) \\
+ 554.34(\text{INV\text{Y}PC}) \\
\quad (328.9)
\]

(standard errors in parenthesis)

\[y: \quad \text{productivity growth.}\]
\[s: \quad \text{private saving rate (s/y) as a share of private national income.}\]
\[\text{DEP:} \quad \text{the youth dependency ratio.}\]
\[\text{GYP\text{C}:} \quad \text{average growth rate of real per capita private national income.}\]
\[\text{RET\text{A}GE:} \quad \text{retirement age, proxied by the qualifying age for public old-age pensions.}\]
\[\text{LPAG\text{E}D:} \quad \text{LF participation rate of males aged 65 and over.}\]
\[\text{INFL:} \quad \text{rate of consumer price inflation.}\]
\[\text{INV\text{Y}PC:} \quad \text{reciprocal of per capita private national income.}\]
\[\text{GDP\text{D}EN:} \quad \text{GDP per square kilometer.}\]
\[\text{AGE:} \quad \text{elderly dependency ratio.}\]
\[\text{G:} \quad \text{annual percentage growth rate of real private national income.}\]
\[\text{B/E:} \quad \text{basic benefit-earnings replacement ratio.}\]
\[\text{CHPR:} \quad \text{(labor force participation rate 25-54 minus participation rate 65 and over) / participation rate 25-54.}\]
\[\text{GDY:} \quad \text{annual growth rate of real per capita disposable income.}\]
According to all of the previous models, an increase in the elderly dependency ratio is associated with a decrease in the private saving rate (see Table 5 below). As Masson and Tryon (1990) indicate, the similar outcomes of each of these estimated models show a significant effect on saving of an increase in the number of elderly as a percentage of the working-age population. Furthermore, the outcomes of these estimations add considerable support to the hypothesis that “the aging of the population projected for the next century is likely to increase consumption relative to income” (463).

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modigliani (1970)</td>
<td>- 0.88</td>
</tr>
<tr>
<td>Modigliani &amp; Sterling</td>
<td>- 0.51</td>
</tr>
<tr>
<td>Feldstein</td>
<td>- 1.21</td>
</tr>
<tr>
<td>Horioka</td>
<td>- 1.61</td>
</tr>
<tr>
<td>MULTIMOD</td>
<td>- 1.10</td>
</tr>
</tbody>
</table>

Chapter 2: Which Theory of Saving?

Although several theories go a long way toward defining the saving function, each theory falls short of its ultimate goal. As Smyth (1993) points out: “[Not] only do we not have agreement on the saving function, but our models have failed to provide us with adequate explanations of saving behavior” (88-89). Consequently, older theories continue to be adapted and new theories tested in attempts to more accurately define the saving function and to more closely explain saving behavior. This chapter first discusses the foundation of the “life-cycle” framework that is used in this paper and then introduces several alternative modern theories with a brief description of each.

According to most models, saving is a multiperiod decision based on the relationship between income and consumption. Depending on the particular model being used, the relationship between these variables may vary slightly. In a simple model of saving, an individual sets out to maximize utility, where utility is a function of consumption in all periods and is constrained by income and a given rate of interest (r). The rate of interest is the rate at which present and future quantities of a good can be exchanged for each other. Simply, \( U = U(C_t, C_{t+1}) \).

This two period analysis can be extended over any number of \( n \) periods where the maximum amount that can be consumed in any period \( t \) is equal to the present value \( (PV_t) \) of total future income or:

\[
PV_t = \Sigma[Y_{t+n}/(1+r)^n].
\] (1)

This procedure of relating consumption and saving to the present value of a future income stream is common to two modern theories of saving, the
Permanent Income Hypothesis (PIH) and the Life-Cycle Hypothesis (LCH). This particular study is grounded in the theory of Modigliani’s “Life-Cycle” Hypothesis. However, this framework is only one of several modern theories of saving that economists have developed in an attempt to explain saving behavior. A short discussion of the PIH and LCH, as well as other modern theories is carried out next.

The Permanent Income Hypothesis (PIH)

The PIH was introduced in 1957 by Milton Friedman. This theory models consumption and saving behavior under the simplifying assumption that life is infinitely long, an obvious weakness in the model. Freidman postured that consumption is related not to an individual’s current income, but to the present value of an individual’s lifetime income stream, or what he referred to as “permanent income”. According to Dornbusch and Fischer (1994), “permanent income is the steady rate of consumption a person could maintain for the rest of his or her life, given the present level of wealth and income earned now and in the future” (308). Consequently, this is a measure that can not be directly observed, another shortcoming the model.

Because permanent income cannot be directly observed, it usually differs from measured income. The difference between measured income and permanent income is referred to as transitory income. In a simple model, it can be explained that income is the sum of permanent and transitory income:

$$Y = Y^p + Y^t.$$  \hspace{1cm} (2)
From this relationship, it can be seen that consumption and saving are the sums of their respective permanent and transitory values:

\[ C = C^p + C^T \quad \text{and} \quad S = S^p + S^T. \]  \hspace{1cm} (3)

Finally, from the previous relationships we can derive permanent consumption and saving by substitution:

\[ C^p = (c_p)(Y^p) \quad \text{and} \quad S^p = (1-c_p)(Y^p) \]  \hspace{1cm} (4)

where \( c_p \) and \( 1-c_p \) are the marginal propensities to consume and save, respectively, out of permanent income.

As discussed in Smyth (1993), Friedman makes several assumptions concerning the correlation between permanent and transitory values of income, saving and consumption. Specifically, he assumes:

\[ \rho(Y_p, Y_t) = 0; \quad \rho(C_p, C_t) = 0; \quad \rho(S_p, S_t) = 0; \quad \rho(Y_t, C_t) = 0. \]

The assumption that \( \rho(Y_t, C_t) = 0 \), that there is no relationship between transitory income and consumption, is very controversial. This relationship implies that the marginal propensity to consume out of transitory income is zero and consequently, that the marginal propensity to save out of transitory income is one. Empirical analysis has shown this not to be the case. "Smyth and Jackson (1977-78) obtained results that implied the following: \( S_0 = 0, S_p = 0.11, S_T = 0.75 \). Estimates such as these provide strong evidence against Friedman's formulation that posits a marginal propensity to consume out of transitory income of zero" (Smyth, 69).
The “Life-Cycle” Hypothesis (LCH)

The life-cycle hypothesis is concerned with the relationship between income, consumption, saving (including wealth) and age (see Graph 1).

Modigliani (1993) states:

“According to this model, individual consumption reflects the preferred allocation of available life resources to consumption over life, while saving and dissaving perform the function of bridging the gap between the life-cycle of income and the desired path of consumption, taking into account their uncertainty. In this view, individual saving arises primarily from ‘hump-saving,’ transitory accumulation of wealth destined for later expenditure. In addition, some of the accumulation may end up (by miscalculation or by design) in the form of bequests” (1).

The most basic formulation of the model presumes that an individual early in life is a dissaver as debt is accumulated to finance education, purchase durables (housing, automobiles, etc.), etc. The middle of an individual’s life, an individual’s “working life”, is characterized by a period of saving to pay back earlier debt and to accumulate both real and financial assets for consumption in retirement. Finally, a period of retirement is characterized by the consumption of wealth, in the form of real and financial assets, that was accumulated during the working years. Presumably, individuals will formulate long-run plans that balance their future needs against desires in the present.
Graph 1 below illustrates the LCH in its simplest form. WL denotes the age at which the average individual will retire (or the end of their working life); NL indicates the age at which an individual expects to die.

**Graph 1. The "Basic" Life-Cycle Model**

"The basic assumption of the life-cycle hypothesis is that an individual attempts to maximize over his or her lifetime a utility function that is homogeneous with respect to consumption at different points of time" (Smyth, 71). In other words, individuals will follow a steady rate of consumption throughout their lives as demonstrated in Graph 1, based upon a lifetime stream of resources and not on current income. From this, we can imply about individual saving behavior that "the size of saving over short periods, like a year, will be swayed to the extent to which current income departs from average life resources" (Modigliani, 299a). In other words, saving is linked to the transitory component of income.

As evidence to the LCH, most individuals pursue rather stable life styles; that is, people do not generally save everything in one period with plans of a substantial spending increase in a subsequent period. Rather, people tend to
consume at about the same level in all periods. In any period, an individual can consume more or less than the income generated in that period. Consumption of an amount less than current income, or saving, provides an individual with the opportunity to increase consumption in some future period. Typically, the LCH implies that individuals will transfer some consumption from periods of prosperity (i.e., save) to periods of hardship or scarcity.

In addition to the increase in an individual's income in a given period, expectations regarding future income plays an important role. So, consumption in any period is based upon the increases in income in that period as well as on any increase in income that an individual expects in subsequent periods. In other words, if an individual expects to encounter financial difficulties in the future, then current consumption would be expected to decline (and saving increase) in order to provide for consumption in the future.

Consumption and saving decisions must also consider the rate of interest - the rate earned for saving or that must be paid for borrowing. More specifically, we would expect that higher rates of saving would prevail in the presence of higher rates of interest, and vice versa. In other words, as the rewards for saving (i.e., the interest rate) rises, saving will tend to increase.

In a simple model, assuming no inheritances and no bequests, from equation (1) consumption can be described as follows:

\[ C_t = PV_t/(NL - WL) \quad S_t = Y_t - [PV_t/(NL - WL)] \]  

(6)

where \( C_t \) and \( S_t \) are consumption and saving in period \( t \), \( PV_t \) (present value) is the level of lifetime resources in period \( t \), \( NL \) age of an individual at death, and
WL is the length of an individual's working life (so NL-WL illustrates the period of retirement). Simply, an individual attempts to smooth consumption of their lifetime resources evenly throughout one's life. Furthermore, the present value of income in period $t$ is:

$$PV_t = \frac{Y_t}{(1+r)^t},$$

where $r$ is the real rate of interest in period $t$. Therefore, the present value of lifetime resources is given by:

$$PV_t = W_{t-1} + Y^L_t + E[Y^L_t]$$  \hspace{1cm} (7)

where $W_{t-1}$ is wealth at the end of period $t-1$, $Y^L_t$ is labor income in the current period, and $E[Y^L_t]$ is the present value of expected (future) labor income. Then by substituting this relationship into our earlier equation (6) for consumption and saving we have:

$$C_t = \frac{(W_{t-1} + Y^L_t + E[Y^L_t])}{(NL-WL)}$$  \hspace{1cm} (8)

$$S_t = Y_t - \left\{ \frac{(W_{t-1} + Y^L_t + E[Y^L_t])}{(NL-WL)} \right\}$$  \hspace{1cm} (9)

There are several problems with this relationship. First, the expected value of future labor income cannot be directly observed and must therefore be proxied. Smyth (1993) points out several other problems that result from the assumption implied here that the marginal propensities to consume (and therefore save) out of wealth, current labor income and expected future labor
income are the same, when this may not actually be the case. For instance, liquidity constraints may prohibit an individual from borrowing against future income. Secondly, uncertainty and the assumption of no inheritances raise concerns. Individuals are uncertain about the exact time that they will die and will likely account for this by using a higher life expectancy (NL). Consequently, bequests and inheritances will result.

Just as in the case of the PIH, there are clearly weaknesses to the LCH as well. These weaknesses have led researchers to try to develop other models that more accurately explain saving behavior. Some of these models are briefly discussed below.

The Wealth Adjustment Model

In the previous two models, PIH and LCH, wealth was used to assist individuals in smoothing consumption over their lifetimes. In both of these models, we assumed that individuals were able to determine, precisely, expectations of their futures such that they could plan for consumption over their lifetimes. In the wealth adjustment model, just the opposite is assumed – that individuals are myopic and unable to formulate a plan of consumption for the future. Consequently, “They want wealth for what can be called a ‘precautionary motive’” (Smyth, 76). In a simple model, an individual has some optimal level of wealth which is a portion of their income or:

\[ W_t = w Y_t, \]  

(10)
where \( w \) is a fraction (i.e., \( 0 \leq w \leq 1 \)) of wealth out of income, \( Y_t \). Due to liquidity constraints, an individual may not be able to adjust to a desired level of wealth in any one period, but that partial and constant adjustments are made over time. Smyth (1993) points out that if \( \beta \) is the constant proportion of adjustment (i.e., \( 0 \leq \beta \leq 1 \)), it indicates "the divergence between desired wealth and the existing stock of wealth" (76). Therefore, saving is the intertemporal change in wealth such that:

\[
S_t = W_t - W_{t-1} = \beta(W_t - W_{t-1}) - \epsilon_t. \tag{11}
\]

Substituting (10) into (11), we derive the following:

\[
S_t = \beta(w Y_t - W_{t-1}) - \epsilon_t
\]

\[
= \beta w Y_t - \beta W_{t-1} - \epsilon_t.
\]

**Error Correction Models**

Modern theories of saving have not performed well on recent data. Consequently, new approaches to modeling the saving function have become increasingly more popular. The Error Correction Model is one of these approaches. It should be noted that the models discussed to this point have been founded firmly in economic theory, whereas the Error Correction Model sets aside theory in favor of robust empirical analysis. Here, the "researcher abandons the attempt to obtain a complete theoretical explanation of the relationships between macroeconomic aggregates such as consumption, saving and income" (Smyth, 82). The objective instead becomes obtaining robust
empirical relationships between the variables based on presumed theoretical relationships between the dependent and independent variables. Opponents of this approach are quick to criticize the abandonment of the theoretical framework of a model in order to obtain robust empirical relationships.

Rational Expectations Models

Many researchers are dissatisfied with the approach taken by some of the previously discussed models. Specifically, the PIH, LCH, and Wealth Adjustment Models assume adaptive expectations on the part of individuals. In other words, people adjust their estimates of permanent income each period based upon permanent income in the previous period. Many economists believe that people are more calculating and careful in estimating their future incomes than the adaptive expectations assumption indicates. This has led to the development of a "rational expectations" approach to describing life-cycle behavior. "For example, households might try to specify a numerical model of how their income will develop in future years, based on their specific understanding of the industry and region in which they work, as well as developments in the overall economy" (Sachs and Larrain, 94).
Chapter 3: The Data

The hypothesis that the rate of national saving in the United States is directly affected by changes in the age structure of the population is tested in this paper. Specifically, the relationship between the changes in the rate of saving and changes in the elderly dependency ratio (which describes changes in the age structure of the population) is investigated.

As previously discussed, saving can be defined by numerous different methods depending on a researcher’s needs and intended inquiry. The analysis in this paper is concerned with the real Net National Saving Rate (the sum of the rates of household, business, and government saving), and is calculated using NIPA aggregate data published by the Department of Commerce in Survey of Current Business and on the Bureau of Economic Analysis website. The net national saving rate, as utilized in this paper, may be derived in a number of ways as illustrated below:

\[
nnsr = \frac{NNP - NC}{NNP} = \frac{(GNP - CCA) - (HHC + G)}{(GNP - CCA)}
\]

or

\[
nnsr = \frac{NNS}{NNP} = \frac{GNS - CCA}{GNP - CCA} = \frac{GNS - CCA}{NNP}
\]

where:

NNP = Net National Product (Gross National Product minus a capital consumption adjustment).
NC = National Consumption (Household consumption plus government expenditures).

GNP = Gross National Product.

GNS = Gross National Saving (the sum of household, business, and government saving).

CCA = Capital Consumption Allowance.

HHC = Household Consumption.

G = Government Expenditures.

It was necessary to transform these nominal data values to control for the effects of inflation. The implicit price deflator was used to convert all nominal values to real values. For example, real gross national product is given by:

$$ GNP_t = \left[ \frac{\text{Nominal} \ GNP_t}{ipd_t} \right] \times 100 $$

where, \( GNP_t \) is the real gross national product in year \( t \) and \( ipd_t \) represents the implicit price deflator in year \( t \). The implicit price deflator used (1996 = 100) is published by the Bureau of Economic Analysis in Survey of Current Business.

In this study, real per capita national income is used which is derived as follows:

$$ nnpcap_t = \frac{NNP_t}{POP_t} $$

where, \( POP_t \) is the total population of the United States in period \( t \).

There has been considerable controversy over certain methods which are used to calculate the rate of national saving. For instance, there is no single
accepted definition of “national saving.” Furthermore, the accuracy of NIPA aggregate data that is used to measure “saving” has been questioned on the basis that it is not directly observed, but rather imputed from the measurements of income and consumption.

Many researchers also point out that saving rates which utilize NIPA aggregate data understate the actual rate of saving. Specifically, they point to the fact that saving, defined as the difference between income and consumption, counts such things as durable goods as consumption in the current period. However, since these goods are not completely consumed in the current period, but rather over the period of several years, that portion not consumed in the current period should be counted as saving (or investment) and not as consumption. In failing to do so, the rate of saving is understated by the amount of durable goods that are not consumed in the period in which they are purchased.

In addition to the inclusion of durable goods as saving, some have argued that other expenditures included as consumption in NIPA aggregates should be counted as saving as well. Some examples of this include: government expenditures on investment type goods (i.e. - spending on infrastructure); public and private expenditures on research and development, and educational services; and efforts to increase human capital as measured by an estimate of the earnings that students forego while attending school (CBO, xiii). Some argue that such expenditures should be counted as investment or saving rather than consumption since they produce benefits well into the future. The difficulty
encountered in counting part of these expenditures as saving or investment is that estimating a rate of depreciation on such expenditure becomes even more difficult than doing so for physical capital.

Another concern in measuring the rate of net national saving stems from questions regarding the accuracy of estimated depreciation. Specifically, depreciation cannot be measured directly and must therefore be estimated. Consequently, the accuracy of these estimates has been challenged.

In 1995, the Bureau of Economic Analysis published substantial revisions to the methods that are used to estimate depreciation of capital equipment (Survey of Current Business, January/February, 1996). As a result of these changes in methodology, estimates of depreciation were revised upward for all years. More than half of the decline in the net national saving rate can be attributed to an increase in depreciation (CBO, xii). Many researchers have argued that estimates of depreciation are too high. If this is the case, then overestimation of depreciation would imply that the decline in the net national saving rate is not as drastic as current figures indicate.

Before the revisions in the methodology used to estimate depreciation, figures were calculated based on the assumption that depreciation followed a linear pattern. For example, if a particular piece of capital equipment was assumed to have a ten-year life expectancy, then its value was depreciated by ten percent in each subsequent year following its purchase. In other words, a $10,000 piece of equipment will decline in value by $1,000 for each year of its life-cycle as illustrated in Graph 2 below. However, studies have determined that
depreciation does not follow a linear pattern, rather a geometric distribution (see Graph 2 below). Specifically, the value lost to depreciation in the first year was greater than in each of the subsequent years of the life of the capital equipment. With this geometric distribution of depreciation, “prices of used equipment tend to decrease by an equal percentage rather than by an equal dollar amount” (Survey of Current Business, 25-26).

**Graph 2. Linear Depreciation Methods vs. Geometric Depreciation Methods.**

The elderly dependency ratio is determined using population estimates published by the Bureau of the Census and labor force data published by the Bureau of Labor Statistics. The elderly dependency ratio is the ratio of the population that is eligible to receive public pension benefits (typically retirees aged 65 and older) as a portion of the total labor force. For the purpose of this study, the elderly dependency ratio (denoted AGE in the studies discussed in
Chapter 1, and OLD in the model used in this study) has been calculated as follows:

\[ \text{OLD} = \frac{\text{Population aged } 65+}{\text{Labor Force Aged } 20+} \]

The youth dependency ratio is determined in a similar fashion to the elderly dependency ratio. Here, we consider the number of youth dependents (in this study, those aged 0 to 19) as a portion of the labor force or:

\[ \text{YNG} = \frac{\text{Population aged } 0 \text{ to } 19}{\text{Labor Force Aged } 20+} \]

The variable “expect”, describes the average life expectancy for individuals living in the United States and is published by the Bureau of the Census.

The real rate of interest, \( r \), used in this study is the average of monthly figures published by the Federal Reserve for the yield on U.S. Government bonds with a maturity over ten years. Nominal interest rates \( i \) are converted to real values by subtracting inflation from nominal figures where inflation is derived as follows:

\[ \text{inflation} = \frac{i_{pd} - ipd_{r-1}}{ipd_{r-1}} \]

where, the real rate of interest, \( r \), is determined as follows:

\[ r = i - \text{inflation}. \]

According to the LCH, the level of wealth in the economy should also be an important determinant in the saving function. Specifically, the higher the level of real wealth (here, the level of tangible assets), the lower the rate of saving in the economy. In other words, there should be an inverse relationship between the level of wealth and the rate of saving in the economy. The wealth variable
used in this study is a measure of tangible wealth published by the Bureau of Economic Analysis in *Survey of Current Business*.
Chapter 4: The Model

Although the model that is utilized in this paper is designed to analyze the
effects of population aging on the rate of national saving, and not just private
saving, some comparisons will be made to models of private saving that were
discussed earlier in this paper. Of particular interest will be comparisons of the
relationship between the age structure of the population and the rate of saving.
The differences that exist here result from the fact that the combination of both
public and private saving is considered; whereas, the earlier models are
concerned solely with private saving data. However, the age variable used in all
of these models, the elderly dependency ratio, is relatively similar throughout all
of the models with only minor differences. Given this similarity, comparisons can
be made regarding the general relationship between age and the rate of saving
as they pertain to the life cycle hypothesis.

One other significant difference concerns the periods covered. These
earlier models generally covered shorter periods where the saving rate remained
relatively stable. The period involved in this study is from 1959 through the third
quarter of 1999. Consequently, I have a relatively larger number of observations.
Possibly of greater significance is the fact that the rate of saving fluctuated
greatly during the time frame with which I am concerned, whereas it remained
relatively stable during the periods in which these earlier studies were conducted.

According to the life-cycle hypothesis, various demographic factors play
an important role in the determination of saving. These factors include fertility,
life expectancy, and the expected length of retirement. Additionally, saving
should also depend on economic factors such as net worth (or wealth), growth, and real interest rates.

This paper endeavors to explain the variation in the rate of national saving as a function of the age structure of the population, along with other relevant economic variables. The general functional form of the model follows:

\[ nnsr_t = f(nnpcap_t, gnnpcap_{t-1}, nnw_{t-1}, old_t, yng_t, expect_t, r_t) \]

where, \( nnsr_t \) is the real net national saving rate in year \( t \); \( npcap_t \) is real per capita net national income; \( gnnpcap_{t-1} \) is the growth rate of real per capita national income lagged one period; \( nnw_{t-1} \) is real net national wealth lagged one period; \( old_t \) is the elderly dependency ratio in period \( t \); \( yng_t \) is the youth dependency ratio in period \( t \); \( expect_t \) is the average life expectancy in period \( t \); and \( r_t \) is the real rate of interest in period \( t \).

Modigliani (1993b) points out the fact that the [national] saving rate is independent of per capita income. The assumption here is that a percentage increase in per capita income will result in an equal percentage increase in consumption such that the saving ratio remains unchanged. On the other hand, the rate of income growth plays a deciding role in saving. Specifically, "... the saving rate depends critically on the rate of growth in the following sense: (i) with zero growth, the saving will be zero, regardless of income or thrift habits; (ii) there can be saving only when there is growth..." (257). Therefore, growth, regardless of its source (i.e., population or productivity), is the major determinant of the rate of national saving according to the life-cycle hypothesis.
Consequently, in my model, we should expect to find a significant direct relationship between the rate of saving and growth of real per capita national income.

Counterintuitive to the assumption that per capita income should have no effect on national saving, this variable is included in my model. This assumption implies that household (or personal) saving should not be affected by changes in the level of resources to be allocated over an individual’s lifetime. However, changes in per capita income may have an effect on national saving through changes in government saving. In other words, as income per capita increases, tax revenues would be expected to rise, holding all else constant. The result would be an increase in government saving which would lead, indirectly, to an increase in national saving. If this relationship holds, we would expect a direct relationship between per capita income and national saving through changes in government saving.

Similar to earlier models, dependency ratios are used in this study to determine changes in the age structure of the population. The current aging of the population in the United States can be attributed to two sources: (1) the decline in birth rates following the post-WWII ‘baby-boom’ and (2) the decrease in mortality rates (According to the Bureau of the Census, the average life expectancy in 1960 was 69.7 years as compared to 76.23 years in 1999). What has resulted is a population where the relative number of old who dissave has increased faster than the number of working age population that save. Accordingly, we should see a decrease in the rate of national saving as
dependency ratios rise. Of particular interest here are changes in saving associated with changes in the elderly dependency ratio. Given the aging of the population, and the assumption that the propensity to consume of the aged is greater than that of the young, the effect on the rate of saving due to increases in the elderly dependency ratio should be significant.

The effect on the rate of saving of the youth dependency ratio is also investigated here. However, one problem that may be foreseen here is that the youth dependency ratio may not give a true indication of the effect of this portion of the population on national saving. For instance, it may be a more clear indication of the relationship between the children and their parents. And the exact age group under which parents may fall (i.e., savers or dissavers) may influence whether the youth ratio has a direct or indirect effect on the rate of saving. Consequently, this ratio may be somewhat difficult to predict and interpret.

Given the motives for saving relative to the ‘life-cycle’ theory, the length of retirement should play some role in determining saving. That is, if saving is a means to provide for consumption during retirement then individuals must save more throughout their working lives if they expect to live longer. Since 1960, improvements in mortality have resulted in an increase in life expectancy. As a result we should expect the rate of saving to increase in order to provide for consumption over a lengthier period of retirement, all other things equal. This is the justification for including a variable measuring average life expectancy.
The life cycle hypothesis also states that changes in wealth will affect the rate of consumption, and therefore saving. During the period from 1960 to present, we have seen a dramatic increase in the wealth of the average individual. Individuals with higher levels of wealth therefore should have less incentive to save. In this model, a measure of tangible wealth is used to estimate the effect of the level of wealth on the rate of saving. Particularly, according to the LCH, changes in wealth in the previous period influence consumption (and therefore saving) in the current period. The dramatic rise in wealth during this period may explain some of the decline in saving. In other words, with a larger store of wealth that can be consumed during retirement, there is less incentive for an individual to save. Consequently, we should expect to find an indirect relationship between wealth and the rate of saving in my model.

The rate of interest should also play an important role in individuals' decisions to save. Since interest rates determine the rate at which individuals can trade off current consumption for future consumption (as explained earlier in discussions of the PIH and LCH), high rates of interest should lead to high levels of saving.
Chapter 5: Results

Some earlier studies have encountered problems of heteroscedasticity related to the income variable – real, per capita net national income in this study. These problems were typically corrected by deflating all variables by the income variable. However, visual analysis of the squared residuals plotted against time does not appear to indicate the existence of heteroscedasticity in this particular study (see Graph 7 in the Appendix). Hypothesis testing was conducted to confirm this.

A White test (Pindyck and Rubinfeld, 1998) for heteroscedasticity was conducted with the following results:

\[ H_0: \sigma_1^2 = \sigma_2^2 = ... = \sigma_n^2 \]
\[ H_A: \sigma_i^2 = CX_i^2 \]

where the appropriate test statistic is:

\[ NR^2 \sim \chi^2_{df-1} = (39)(.003) = .117. \]

Since .117 is less than the critical value of \( \chi^2 (3.84) \), we fail to reject the null hypothesis of homoscedasticity.

The model was originally estimated using ordinary least squares procedures. However, estimation of the original specification resulted in severe multicollinearity problems (see Table 6 below) among several of the variables in the model. Therefore, attempts were made to estimate the dependent variable (national saving rate) as a function of various groups of explanatory variables. The results of least squares estimates can be seen in Table 8 below.
Table 6. Correlations from OLS Estimation.

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Table 7. Results of OLS Estimation Procedures.

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<th>R²</th>
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Note: Values in the first row indicate the estimated coefficient; t-values appear in parentheses.

In addition to severe multicollinearity, visual analysis of the data plotted over time seems to indicate positive serial correlation as well (see Graphs 1 through 6 in the Appendix). This can be confirmed by examining the results of the least squares estimates above. In order to adjust for this problem, the equations are re-estimated using maximum-likelihood procedure.

The maximum-likelihood estimates appear in Table 9 below. The fit of the saving equations that were estimated is generally good, as can be seen by the values of $R^2$ and $R^2_{adj}$ that are included in the tables. Additionally, most of the estimated coefficients have the expected signs.
Table 8. OLS Estimates for Restricted Models.

Notes: (i) The dependent variable is the net national saving rate.
(ii) The sample period is 1959 - 1999:III.
(iii) The upper figure is the estimated coefficient; t values appear in parenthesis.

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<th>gnp</th>
<th>nw</th>
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Notes: (i) The dependent variable is the net national saving rate.
(ii) The sample period is 1959 - 1999:III.
(iii) The upper figure is the estimated coefficient; t values appear in parentheses.

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\begin{align*}
\text{constant} & = 0.0221, \quad \text{nnpccap} = 1.30E^2, \quad \text{gennpca} = -1.28E^5, \\
& (0.708) \quad (3.975) \quad (-4.88) \quad 0.7354 \quad (5.911) \quad .841 \quad .837 \quad 1.637
\end{align*}

\begin{align*}
\text{constant} & = 0.1327, \quad \text{nnpccap} = -3.30E^6, \\
& (10.03) \quad (-4.201) \quad 0.6007 \quad (4.318) \quad .779 \quad .773 \quad 1.537
\end{align*}

\begin{align*}
\text{constant} & = 0.0772, \quad \text{nnpccap} = 0.2286, \\
& (6.264) \quad (3.215) \quad 0.8699 \quad (11.61) \quad .781 \quad .775 \quad 2.262
\end{align*}

\begin{align*}
\text{constant} & = 0.1268, \quad \text{nnpccap} = -3.24E^6, \\
& (10.613) \quad (3.282) \quad (-4.676) \quad 0.5771 \quad (3.809) \quad .827 \quad .822 \quad 2.007
\end{align*}

\begin{align*}
\text{constant} & = 0.091, \quad \text{nnpccap} = -0.3637, \quad \text{gennpca} = 0.1051, \\
& (.4167) \quad (-.4391) \quad (6.336) \quad 0.4658 \quad (3.001) \quad .803 \quad .798 \quad 1.497
\end{align*}

\begin{align*}
\text{constant} & = -1.567, \quad \text{nnpccap} = -2.285, \quad \text{gennpca} = 0.4308, \quad \text{old} = 0.0263, \\
& (-2.266) \quad (-2.289) \quad (3.434) \quad (2.541) \quad 0.304 \quad (1.817) \quad .828 \quad .824 \quad 1.575
\end{align*}

\begin{align*}
\text{constant} & = 0.1985, \quad \text{nnpccap} = 0.2672, \quad \text{gennpca} = -0.7835, \quad \text{old} = 0.1036, \\
& (.9599) \quad (3.593) \quad (-.9939) \quad (7.814) \quad 0.3722 \quad (2.046) \quad .853 \quad .849 \quad 1.932
\end{align*}

\begin{align*}
\text{constant} & = -1.545, \quad \text{nnpccap} = 0.3294, \quad \text{gennpca} = -3.379, \quad \text{old} = 0.4382, \quad \text{yng} = 0.0295, \\
& (-3.497) \quad (5.212) \quad (-4.905) \quad (5.886) \quad (4.478) \quad (-.379) \quad .892 \quad .889 \quad 1.884
\end{align*}

\begin{align*}
\text{constant} & = 0.2026, \quad \text{nnpccap} = 6.90E^6, \quad \text{gennpca} = -1.75, \quad \text{old} = 0.2474, \\
& (.9737) \quad (3.166) \quad (-1.945) \quad (5.123) \quad 0.539 \quad (3.709) \quad .847 \quad .843 \quad 1.698
\end{align*}
The coefficients of real per capita national income are positive and significant in most cases, regardless of the estimating procedure used. In other words, the results agree with the theory that there is a direct and significant relationship between income and the rate of national saving.

Estimation results indicate that the coefficients for the growth rate of real per capita income, gnnpcap(-1), are also directly related to saving and significant. The estimated coefficients range in value from .2282 to .2731. This supports the assumption that growth in income leads to an increase in saving.

The estimated coefficients of the net wealth variable, nnw(-1), are negative, and significant in each case where they are included. The values for this coefficient ranged from -3.24E-6 to -1.282E-5. The results support the assumption that increases in wealth would induce individuals to save less.

The interest rate was also expected to have a direct relationship with the rate of saving. The estimated coefficients do support this, with values of the coefficients ranging from .1551 to .5140; however, they are not always significant. This results from the high degree of multicollinearity that exists.
between this variable and others (see Table 6). Consequently, the coefficient of the interest rate and other variables may become insignificant when two or more of these variables are introduced together. This can be seen in Table 8 and Table 9.

Of greatest importance in this study is the relationship between demographic variables, old and yng. Here, we are interested in testing the hypothesis that saving will decrease as the age structure of the population changes, or more specifically that there is an indirect relationship between saving and dependency. The estimated coefficients for the elderly dependency ratio, old, support this hypothesis. The values of the estimated coefficients range from -3.637 to -3.379 and are significant in most cases. These values are comparable with the estimated coefficients in previous studies (see Table 5). On the other hand, the estimated coefficients for the youth dependency variable do not agree with the expectations of an indirect relationship between dependency and saving. Here, the values of the coefficients are positive, ranging from 0.1036 to 0.4382, and are generally significant. However, it should be noted that multicollinearity exists between this variable and several others in the model (as can be seen in Table 6 above).

In addition to the dependency ratios, it is expected that changes in the average life expectancy would also affect individuals’ saving decisions. Specifically, if an individual expected to live longer, they would adjust their saving behavior to save more in order to compensate for a longer retirement period. In
other words, their propensity to save would be adjusted upward. Coefficients ranging in value from .0106 to .0295 support this assumption.
Chapter 6: Conclusions, Limitations, & Suggestions

The major focus of this paper has been to test the assumption of the life-cycle hypothesis that the age structure of the population should be a significant determinant of the rate of saving. The results of this study suggest that the age structure of the population is a significant factor in determining the saving rate in the United States, at least with respect to the elderly portion of the population as measured by the elderly dependency ratio. The estimated coefficients of the elderly dependency ratio were negative and generally significant. Furthermore, the values of the coefficients were similar to those found in most of the previous studies discussed earlier in this paper (refer to Table 5 and Table 9 for comparisons of coefficients of previous studies and the current study, respectively).

The results of this study also support other assumptions of the life-cycle hypothesis. Specifically, income growth is expected to have a positive and significant effect upon the rate of saving. The estimated coefficients in this study support this assumption (see Table 9).

Additionally, results indicate that the other explanatory variables included in this paper - the level of wealth, the interest rate, and life expectancy - are generally significant and have expected signs.

However, some limitations should be considered when interpreting the results reached in this study. First, due to severe multicollinearity between several explanatory variables in the original specification of my model, some variables could not be estimated jointly, and must therefore be considered
separately. Secondly, some other factors that should affect the saving function but were not included in the model due to insufficient data. Specifically, the benefit/earnings replacement ratio, or the ratio of income that is replaced by pension benefits, would be expected to have a significantly indirect effect on saving. These results depend on the assumption that the model estimated here is specified correctly. However, if variables such as the B/E replacement ratio do bear significance in the saving function, then some of the estimated coefficients will account not only for their effect upon the dependent variable but also for the effects of such omitted variables. In such a case, the estimated coefficients would be biased.

Attempts were also made in this study to estimate savings as a function of specific age groups (i.e., age 20-34, 35-44, 45-54, 55-64, 65+) as well as the other explanatory variables used in this study, rather than using dependency ratios. However, just as problems of multicollinearity were encountered in the estimation of the model as specified, problems were even more severe when attempting to include individual age groups. Modification of these variables, to correct for the problems of multicollinearity, may allow for the estimation of a saving function that will provide more robust estimates and a more stringent test of the life-cycle hypothesis.

One further suggestion that may lead to a more accurate estimate of a national saving function would be to conduct a two stage least squares estimation. Here, saving equations might be estimated separately for personal saving, business sector saving, and government saving. The relationships
estimated for each of these individual relationships could then be used to estimate a model of "national saving". This process might allow a researcher to explore the extent to which factors of each individual saving relationship affect changes in national savings. It may also allow for the use of individual age groups in place of dependency ratios, which may result in a more robust and meaningful test of the LCH.
Appendix:

Graph 1.

Real Net National Saving Rate,
1959--1999:III, %.

Graph 2.

Real Net National Income,
Graph 3.

Real Net National Wealth,

Graph 4.

Elderly Dependency Ratio,
1960--1999:III
Graph 5.

Youth Dependency Ratio,
1960--1999:III

Graph 6.

Average Life Expectancy,
Graph 7.

Squared Residuals, OLS Estimation

1960--1999:III
References


Bureau of the Census, Census website, HTTP Address: http://www.census.gov.

Bureau of Economic Analysis, BEA website, HTTP Address: http://www.bea.doc.gov.


