

October 30, 1998
date last saved: 10/30/98 3:59 PM
date last printed: 10/30/98 4:20 PM
Draft

Life Cycle Saving and the Demographic Transition in East Asia

Ronald Lee
Demography and Economics
University of California
2232 Piedmont Ave
Berkeley, CA 94720
E-mail: rlee@demog.berkeley.edu

Andrew Mason
Department of Economics
University of Hawaii at Manoa, and
Program on Population
East-West Center
E-mail: amason@hawaii.edu

Timothy Miller
Demography
University of California
2232 Piedmont Ave
Berkeley, CA 94720
E-mail: tmiller@demog.berkeley.edu

The authors acknowledge the assistance of Jeff Brown and Noreen Tanouye at the Program on Population of the East-West Center and Bryan Lincoln at the NIA supported Center for Economics and Demography of Aging at Berkeley. Angus Deaton provided helpful suggestions on an earlier paper on the same topic. Lee and Miller's research for this paper was funded by NIA grant AG11761. Mason's support for this paper was provided by the Agency for International Development, the Rockefeller Foundation, the William and Flora Hewlett Foundation, and the Ministry of Foreign Affairs of Japan.

Might the demographic transition from high fertility and mortality to low fertility and mortality cause an increase in savings rates and in capital per worker? There is a long literature addressing this important question, and after a period of neglect, there has been new but contradictory research on the topic. Here we return to this issue, extending our earlier work, and attempting to reconcile it with findings from household level data.

We discuss the ways in which demographic change over the transition leads to a substantial increase in the demand for life cycle wealth, which can be held in the form either of capital or of transfer wealth, with transfer wealth arising through familial provision for old age or through pay as you go public pensions. Savings flows arise through an attempt to adjust capital holdings as a residual component of the changing demand for wealth, after transfers are taken into account. In the simulations in this paper, we do not include transfers, although see Lee, Mason and Miller (1997). Our simulations show how age specific and aggregate savings rates would respond over the transition if there were no transfers. Our simulated age patterns of income, consumption, and savings rates for Taiwan agree in some respects, but not all, with survey data from Taiwan. Our simulations also suggest that testing for life cycle saving behavior is more difficult than has been appreciated: age profiles of saving twist in shape and shift in level, and there is no clear relation between population growth rates and saving rates at the aggregate level. We do find, however, that under the assumption of pure life cycle saving, aggregate saving rates would decline during early stages of the transition, then rise quite substantially during a long middle period, and then decline again as the population ages rapidly in the last stage of the transition. We also find, as have others, that the effect on savings of the changing demography interacts with the rate of productivity growth, particularly in the later stages of the transition.

Research on Population and Saving

Fisher (1930), among many others, recognized that life-cycle variation in individual productivity would lead individuals to vary their saving over their lifetime in order to smooth their consumption. Changes in population age-structure, thus, affect aggregate saving. If lifecycle saving is dominated by pension motives, slower population growth leads to reduced saving (Modigliani and Ando (1957)). If lifecycle saving is dominated by childrearing costs, slower population growth leads to increased saving (Coale and Hoover (1958)).

Most theoretical analyses of aggregate saving based on the lifecycle model are comparative static and examine the impact of different steady-state age structures combined with fixed age-schedules of consumption and earning. Mason, 1981, 1987 and Fry and Mason, 1983 consider the impact of demography on the age-schedules of consumption and earning, as well as, on the age structure of the population, but within a comparative-static framework. Higgins (1994) uses a simple overlapping generations model to examine the impact of changes in the number of children on saving in transition between steady-states.

Several empirical studies based on international cross-sections support an important link between demographic change and saving. Leff (1969, 1980, 1984) concluded that declining population growth leads to higher saving rates as the burden of youth dependency declines and, then, to lower saving rates as the elderly population increases. His results have been extensively critiqued (Adams, 1971; Bilsborrow, 1979, 1980; Goldberger, 1973; Gupta, 1971; and Ram, 1982, 1984). More recent studies provide additional evidence that aggregate saving is influenced by demographic change (Mason 1981, 1987, 1988; Fry and Mason, 1983; Kelley and Schmidt, 1997; Williamson and Higgins, 1997).

Analyses at the microlevel are less supportive of an important connection between population and aggregate saving. Household saving rates vary with the demographic characteristics of the household, but the age-variation is sufficiently small that changes in age-structure have only a modest impact on aggregate saving or no impact at all (Deaton and Paxson, 1997; Mason et al., 1993). Deaton and Paxson find a somewhat more substantial impact of demographic change over the transition on household saving in the micro-level analysis presented in this volume, but the impact is much smaller than found by Williamson and Higgins (1997) from cross-national analysis.

A consensus about the importance of demographic factors is unlikely to emerge in the absence of reconciliation of these two approaches. Both face difficult technical problems that are discussed extensively elsewhere (Weil, 1994; Hurd, 1997; Kelley, 1988; Lee et al., forthcoming).

Demographic Change and the Demand for Wealth Over the Life Cycle

During childhood and old age, people on average consume more than they produce through their labor. During the middle years, people produce in excess of their consumption. Consumption in childhood is generally provided by transfers from the child's parents, with whom the child co-resides. Children are not generally financially independent, and they can be treated as part of their parents' planning problem. Support in old age, however, is another matter. Working age people must develop claims on future output beyond their own expected future production; without such claims, they could not consume once they ceased working. Such claims are called "wealth", or sometimes "life cycle wealth". These net claims, or wealth, can be held in many forms, but these forms can all be classified as credit, capital, or transfers. Capital simply means ownership of physical assets (directly or through the stock market or pension funds that hold such assets). Transfer wealth is the present value of the difference between the transfers one expects to receive in the future, and the transfers one expects to make. In traditional societies and in some industrial ones, most people expect to be supported in their old age by their own adult children, with these transfers often facilitated by co-residence. Within a population, it is generally older people around the age of retirement and beyond who hold the greatest wealth.

The accumulation of wealth by households is illustrated in a stylized manner in Figure 1. Adults enter the workforce and begin to accumulate wealth. They continue to do so until they retire. During retirement they draw down their wealth supporting themselves in the absence of labor income. Lifecycle models frequently assume that wealth is accumulated only to support consumption during retirement and declines to zero at death. However, there are many reasons why this may not be the case. Uncertainty about time of death may lead people to over-accumulate wealth on average. People may hold additional wealth as a buffer against uncertain income streams or consumption needs, and people may save to provide bequests for their children. The need to provide for old age consumption is only one of a number of factors that motivates accumulation. Irrespective of the motivation, wealth profiles typically increase with age. The extent to which wealth declines among the elderly is an empirical issue about which there is considerable debate (Hurd, 1997).

Figure 1. Schematic Wealth Profiles

The retirement motive for wealth accumulation is a relatively weak force in a pre-transition population because the expected duration of retirement is so short. For the pre-transition mortality rates used to characterize Taiwan below, a typical individual could expect to live only 0.078 years after age 65 for every year lived between the ages of 20-64. A modest level of wealth (Figure 1) is sufficient to finance average retirement needs in such a population. In a post-transition population, the number of years lived after age 65 per year lived in working ages are greater by a factor of 4 or 5. To provide the same measure of economic support in old age, average wealth also must be substantially greater (Figure 1). (Note that wealth need not actually begin to decline until some years after retirement).

The age-wealth profile also should be influenced by the number of children. If children are costly, an increase in the number of children reduces consumption by adults. If parents smooth consumption over the life-cycle, then an increase in the number of children leads to an increase in consumption, by less than the cost of children, during years in which children are being reared. Consumption during years in which no childrearing costs are being incurred, including retirement years, is lower. Thus, the wealth profile is more bowed and peaks at a lower level. The impact of the number of children is attenuated if there are substantial economies of scale to childrearing or if parents reduce spending on their other children. Changes in the number of children may also influence other saving motives, such as bequests or uncertainty, affecting the wealth profile in ways that cannot be determined a priori.

Non-demographic factors also influence the wealth profile. If people desire to leave larger bequests, the demand for wealth shifts upwards. A higher rate of interest may lead people to postpone consumption, thereby increasing holdings of wealth. However, with higher interest rates the wealth necessary to support a given level of consumption in old age is reduced. Consequently, interest rates have an ambiguous impact on wealth profiles. A higher rate of productivity growth means that the earnings of younger households are lower relative to their expected life time earnings than when the rate is lower. This will lead them to accumulate less wealth when young and their earnings are

low and more wealth when they are older and their earnings are high. Earnings that are sufficiently low at young ages might lead individuals to go into debt if that were institutionally possible.

Total wealth is determined by the wealth profile and the number of adults at each age. If pre- and post-transition populations were stationary and everyone lived to the age of death, wealth per person would be given by the area under the life cycle wealth profile, divided by the number of years of life. From inspection of the figure, we can draw the following conclusions:

- Because life expectancy is greater, wealth per adult will be greater in a post-transition population (provided that increases in the age at retirement do not offset increases in years lived).
- Because families have fewer children, wealth per adult will be greater in a post-transition population (provided that greater expenditures on children do not completely compensate for the decline in the number of children).

A more realistic representation of mortality conditions in pre- and post-transition populations reinforces these effects. A pre-transition population has a relatively large proportion of its population concentrated at younger age where the demand for wealth is relatively low.

The sharp difference between demographics in a pre-transition and a post-transition population are illustrated by data based on the experience of Taiwan (Table 1). The ratio of the expected number of years lived at old ages to working ages is substantially greater in a post-transition population, the average number of children reared is smaller, and the percentage of the population concentrated at older ages is greater. Each of these demographic factors pushes the demand for wealth higher and, in concert, dramatically so.

Table 1. Demographic characteristics of a pre- and post-transition population.

In the stylized model presented in Figure 1, a stationary population had a constant demand for wealth. Tobin (1967) shows more generally that the ratio of wealth to income is constant if labor productivity is growing at a constant rate and the population is stable, i.e., subject to constant fertility and mortality rates and, hence, experiencing a constant population growth rate.

Under these special circumstances, the saving rate is also constant and bears a simple relationship to the equilibrium ratio of K/Y . If K/Y is constant, capital and output must grow at the same rate, i.e., $dK/dt/K = g$, where g is the rate of growth of output. Rearranging terms and dividing by Y , we have $dK/dt/Y = g K/Y$. The term on the left-hand side is the saving rate, s . Hence, in equilibrium:

$$s = g K/Y.$$

If population growth is zero at the beginning and the end of the demographic transition, g is the rate of growth of technology. If it is constant over the demographic transition, then the equilibrium saving rate will vary in direct proportion to the equilibrium ratio of capital to income. The analysis presented below shows that demographic changes over the transition may cause an increase the equilibrium capital-output ratio and the equilibrium saving ratio of three- to four-fold.

The hypotheses advanced above and those obtained from most lifecycle saving models apply to comparative steady states. Demographic conditions that prevail before and after the onset of demographic transition may be approximated reasonably well as being in steady-state, but it is far less likely that populations can be adequately described by steady-state relationships.

The detailed analysis presented below shows that they cannot be. The surviving number of children per family does not decline smoothly over the demographic transition. In the early stages of the transition the number of children increases substantially with mortality decline and then drops only as fertility decline sets in. The age distribution of the population also changes in complex ways over the transition. The population grows younger early in the transition depressing the demand for wealth. A further complexity is that during the transition, each cohort experiences different fertility and mortality. This is particularly important in East Asia where demographic change has been so rapid. Thus, no simple generalizations about the relationship between population, wealth, and saving during transition can be obtained.

What can said, then, about aggregate saving during transition? Two conclusions follow directly from the finding that the equilibrium K/Y is greater after the transition than before the transition. The first conclusion is that elevated saving rates must accompany the demographic transition. An increase in the K/Y ratio during the transition is possible only if saving rates exceed their initial equilibrium value. A saving rate equal to the post-transition equilibrium rate will eventually produce an equilibrium K/Y consistent with the lifecycle model. The second conclusion is that the extent to which saving rates are elevated will depend on the speed of the transition. Countries that reach an equilibrium K/Y in a shorter duration of time can do so only if saving rates are higher during the transition. (The effects of the pace of transition on savings rates are explored in Lee, Mason, and Miller, 1998). Of course, the effects of changes in transfer behavior will be superimposed on these effects, or interact with them.

As is true of K/Y , saving rates at any particular point in time may deviate substantially from these generalizations. As shown in the detailed simulations presented below, depending on the timing and nature of fertility and mortality change, saving rates may decline and rise at various points in the transition.

Given the complexities of the life-cycle model, one can easily overlook an unambiguous implication of changes that occur over the demographic transition. If the increased

demand for wealth per capita were not satisfied, then old people would experience sharp discontinuities in consumption when they no longer worked; possibly they would starve. In fact we do not observe that elders in societies nearing the end of the demographic transition consume at or below subsistence levels. In Taiwan, cross-sectional age profiles of consumption for recent years (to be displayed later) do not show such discontinuities. Consumption per capita in households is very flat across age of head in cross sections (Mason and Miller, 1998). It follows that per capita wealth holdings must have increased substantially over the course of the transition. In one way or another, the elderly have acquired the claims on resources that permit them to consume during longer periods of retirement.

Lifecycle Wealth: Transfer Wealth or Capital

Wealth as we have defined it above is quite general, consisting at the societal level of both transfer wealth and capital. Either form of wealth can be used by the elderly to sustain their consumption. However, transfer wealth has no impact on economic production nor on total income. The accumulation of capital, in contrast, is central to modern economic growth.

In traditional societies, the elderly are supported primarily by transfers within the extended family, either through co-residence with adult children or through transfers between households. Lifecycle wealth is largely transfer wealth, taking the form of expected net transfers in the future, not of holdings of productive property (although livestock, structures and land are also common forms of wealth). If family transfers continued to dominate, the demographic transition would have little impact on capital accumulation.

Economic development typically, perhaps always, erodes the system of family transfers. If the system is replaced by a pay-as-you-go public pension system which transfer income from those who are currently working to those who are currently retired, one form of transfer wealth (public) is simply substituted for another form (private). Under these circumstances, the demographic transition increases transfer wealth (or the size of the public pension system), has a fiscal impact (raising taxes on earnings), but has no direct impact on capital formation.

However, if the family transfer system is replaced by a system based on individual responsibility in which workers accumulate real wealth in order to fund their retirement, then demographic transition leads to increased holdings of capital. The institutional form of the individual responsibility system varies from country to country. Farmers and small businessmen may save by investing directly in productive enterprises. Workers may save directly through a variety of financial instruments or by participating in funded company-sponsored pension programs. Fully funded public pensions would have the same effect. Some countries, Singapore and Malaysia, for example, have now institutionalized such individual "life cycle saving" through large mandatory saving/retirement programs

The shift away from the traditional family support system is evident in East Asia although family transfers are still considerably more important than is true of the West. The percentage of Japanese elderly living with their children declined by 30 percentage points between 1950 and 1990. About half continued to live with their children in 1990 (Feeney and Mason, 1998). In 1973, more than 80 percent of Taiwan's elderly lived with their children (Weinstein et al., 1994). In 1993, sixty percent of elderly men and seventy percent of elderly women were living with their children (calculated by authors employing the Family Income and Expenditure Survey).

The accumulation of wealth depends more on expectations about support by those who are currently working than by the current arrangements of those who have already retired. Surveys of young Japanese adults indicate that they are increasingly likely to discount the family as a future source of old age support. In 1950, 65% of women of childbearing age expected to rely on their children in old age. By 1990, only 18% expected to turn to their children for support in the future (Ogawa and Retherford, 1993).

The following table illustrates how the demographic transition and institutional arrangements for old age support interact to determine saving behavior and capital. The biggest effect on saving rates and on capital formation occurs when the demographic transition is combined with a transition to individual responsibility for old age support.

	Transfers	Individual Responsibility
Pre-Demog Transition	Initial Situation	Small increase in savings and K
Post-Demog Transition	Small increase in savings and K	Big increase in savings and K

In this paper, we analyze the effect of the demographic transition on savings and capital accumulation under the assumption that the system of individual responsibility has existed throughout. This will exaggerate the effect of a movement down the left hand column, passing through the transition while maintaining the system of transfers. It will understate the effect of a movement diagonally from the upper left to the lower right. We believe that this diagonal movement is the most appropriate representation of the changes taking place in East Asia and eventually in other Third World countries. In a number of countries of Latin America, currently switching to mandatory private savings for retirement, the movement to the lower right cell has already taken place or is in process.

THE DYNAMIC SIMULATION MODEL

The simulation model used in this paper determines how aggregate saving rates and wealth change during demographic transition if saving by members of the population is determined entirely by lifecycle considerations. The model is very similar to one used in Lee, Mason, and Miller (1997). The demographic component of the model is detailed and closely tracks Taiwan's experience. The emphasis is on changes in fertility, mortality, family size and age-structure over the demographic transition. The model does not consider the impact of immigration; however, a realistic treatment of immigration does not alter results in any important respects (see Lee, Mason, and Miller (1997).)

Time paths of life expectancy at birth (e_0) and the total fertility rate (TFR) are specified. We then derive age specific rates from these summary measures by assuming that rates for age x , time t , are described by: $m_{x,t} = a_x + b_x k_t$, where a and b are age specific parameters that do not change over time, and k is an index of the level of mortality or fertility (see Lee and Carter, 1992; Lee, 1993). The trajectory of k then determines the trajectory of mortality or fertility, and the time path of k can be chosen to match the time path of e_0 or TFR. The vectors a and b are chosen to provide a good fit to Taiwanese historical experience, but the same vectors can also fit the experience of other populations reasonably well. This setup makes it easy to experiment with alternative demographic scenarios. In this paper (unlike our previous) we assume that the population is closed to migration. This means that we ignore the demographic effects of the migration from the mainland to Taiwan, which is an unfortunate implication of the greater generality of our current approach. We refer to the resulting transition as “Pseudo-Taiwan.” The trajectories for life-expectancy at birth and the TFR for Taiwan, as well as the implied population growth rates, are shown in Figure 2. The TFR is assumed to move slowly to replacement level in future decades, and life-expectancy at birth is assumed to rise to nearly 80 years by 2050.

Figure 2. Life-expectancy at birth and the total fertility rate, Taiwan

We assume that children remain in the parental home, pooling their income with that of their parents, until age 25, although some marry and begin childbearing at an earlier age. Until this age, their income is treated as income of their parents, and its disposition is governed by the parents' life cycle budget constraint and consumption plan. In fact, in 1980, only about a quarter of males aged 25-29 were household heads, so the actual age of leaving home is typically later than 25. However, we expect (with no direct evidence) that co-resident children would increasingly have control over their earnings as they grow older, whether or not they remain co-resident. Once children leave home and set up their own households, we assume they remain in their own households for the remainder of their lives.

The household saving model is an extension of Tobin's (1967) formulation and is somewhat similar to Attanasio et al. (1997) although their model incorporates uncertainty and precautionary savings in addition to demographic factors. Household behavior is governed by a utility maximization model. In each period, adults decide how much of their income to consume and how much to save based on their current wealth, family size, interest rates, and expectations about future childbearing, mortality conditions, and earnings. We make no allowance for intergenerational transfers, i.e., parents make no bequests to their children and adult children provide no support to their parents. (Lee, Mason, and Miller (1997) analyzes the impact of transfers.)

Our integration of demographic factors into the life cycle saving model is straightforward extension of earlier work. Each couple calculates the present value of expected life time earnings, including the earnings of co-resident children. The present value of expected lifetime household consumption is constrained to equal this amount. Couples distribute

household consumption over time so as to maximize their life time utility. Given the life time utility function employed, household consumption per equivalent adult consumer rises at a rate equal to $(r-\rho)(1/\gamma)$, where r is the real rate of interest, ρ is the rate of subjective time preference, and $(1/\gamma)$ is the intertemporal elasticity of substitution. In our simulations, we take ρ to be 0. For $(1/\gamma)$ we use an estimate of .6 for Taiwan by Ogaki et al (1996). We assume that the weight of children in consumption calculations by their parents rises with the children's age, and averages 0.5. Additional elements of the simulation model are described in the appendix to Lee, Mason and Miller (1997). (Because saving rates are always positive in the simulations presented here, we do not impose non-negative wealth constraint in these simulations.)

For life cycle planning, it is anticipated future values of the demographic and economic variables that matter. We assume that couples' correctly anticipate their fertility and the survival of all family members. These expectations take the form of proportions or probabilities, but we assume that all the uncertainty around these average rates is absorbed by institutions, whose exact nature we do not consider. We would like to experiment with the assumption that couple's base their planning on current period life tables rather than foreknowledge of future life tables, but have not yet done this.

Earnings in each year are determined by changes in the general wage level, the productivity growth rate, and a fixed cross-sectional age-earnings profile. The profile is equal to the average shape over the years 1976 to 1990 in Taiwan calculated from the Family Income and Expenditure Survey. The level of this profile shifts according to the assumed rate of productivity growth. We depart here from the standard implementation of the life cycle model, which has assumed that the longitudinal earnings profile has a fixed shape. We believe our specification to be preferable on both theoretical and empirical grounds as discussed in Lee et al. (forthcoming).

For the interest rate and productivity growth rate, we do not assume perfect foresight. We instead make the ad hoc assumption that people base their expectations on the average experience of the past five years. Then, rather than assuming this rate to continue for the rest of their lives, they expect the rate to tend exponentially toward a long run target rate, which is their long run future expectation. These we have taken in our baseline simulation to be $r=.03$, and productivity growth = .015. Our thought is that long-term interest rates will converge to international levels as global capital markets are increasingly integrated and that productivity growth will depend only on technological advance at a rate similar to those experienced in mature economies once the economy reaches equilibrium. Since r has averaged 7.4% since 1950, and productivity growth has averaged 5.5%, we are assuming that people are constantly surprised by continuing high rates. Our analysis is inconsistent, because although people are repeatedly surprised by economic outcomes, they continue to believe that they know the future with certainty. It would be preferable to develop a model incorporating both uncertainty and demographic factors (see Attanasio, 1997), but that is beyond the scope of this paper.

We start the simulations in 1800, to permit convergence to the steady state before the transition begins. Results are presented either for 1900 to 2050 or, occasionally, from 1950 to 2050. We show results from a variety of specifications, but we have made no

effort to fine tune the simulations to match Taiwanese experience. Our baseline throughout assumes that the productivity growth rate rises from a pre-transition level of 1%, peaks at 5.5% over the period 1950-99, and then declines to a long-run average of 1.5%. The interest rate is set at 1.5 percentage points above the productivity growth rate. We also assume that the long run expectations remain unchanged at .03 for the interest rate and .015 for the productivity growth rate, and a zero rate of time preference.

Results of Simulations

We begin by briefly examining the baseline simulation, assessing how saving and wealth vary over the demographic transition. Next we consider how changes in two key variables influences the outcome. Then we turn to a more extensive consideration of the consistency of the simulation results (and the lifecycle model) with Taiwan's actual saving experience.

Figures 3 and 4 chart the trend in saving and wealth from 1950 to 2050 for the baseline simulation and several alternatives. The most prominent feature of the baseline simulation is the very substantial swing in saving that begins about 1973. The saving rate increases by almost 14 percentage points, doubling the 1973 rate by the time it peaks. The increase in the baseline is followed by an even greater decline in the saving rate. The large swing in saving is a phenomenon that is missed entirely by comparative static analyses but was noted above as an outcome of rapid demographic transition under life cycle savings. The swing in saving rates is accompanied by a rapid increase in K/Y .

A second important feature of the saving simulation is the dip that occurs in the 1960s and early 1970s. This dip in savings is related in complex ways to the changing numbers of surviving children in households.

In the baseline simulation, demography, interest rates, and productivity growth rates are all changing and influencing the outcome. The direct impact of demography is isolated by a simulation which holds the interest rate and productivity growth rate constant at 3 and 1.5 percent, respectively, throughout the simulation. If only demographic factors change, the saving rate reaches a higher peak and declines more modestly than in the baseline. Note, however, the artificial nature of assuming a constant rate of interest (return to capital) and a constant productivity growth rate in light of the large increase in capital. In a more complete model of the economy, currently being developed, interest rates and growth would be determined in large part by the changes in capital induced by demographic factors. As K/Y approaches its equilibrium level, productivity growth would decline to a lower long-term growth governed solely by technological innovation.

Figure 3. Simulated Savings Rate: Pseudo-Taiwan, 1950-2050

Figure 4. Simulated Wealth/Output Ratio: Pseudo-Taiwan, 1950-2050

The impact of variations in the interest rate and the rate of productivity growth are considered by reducing the difference from the terminal values in half (Figure 5). The impact is to lower the saving rate rather uniformly and independently of the demographic

forces. The impact of changing demography is substantial and qualitatively the same whether interest rates and productivity growth rates are as high as has been the case in Taiwan or substantially less.

An increase in the interest rate holding the rate of productivity growth rate constant is also shown in Figure 5. A higher interest rate leads to a substantially higher saving rate irrespective of demographic conditions. Likewise, the impact of demography on saving is relatively independent of the interest rate.

Figure 5. Simulated Saving rate with lower return to capital, higher interest rate.

Assessment of the Simulations and the Lifecycle Model

We have tested the sensitivity of our results to the choice of input values for parameters such as elasticity of intertemporal substitution, equivalent adult consumer weights, expectation formation, for example. However, we have made no effort to fine tune the input parameters to produce results that match the Taiwanese survey or national income account data. Given the many parameters of the model, tailoring the assumptions to improve the fit to the observed results is an option. For example, raising the long run expected interest rate from .03 to .04 would make the simulations fit the survey data considerably better, by raising saving rates at younger ages. However, excessive experimentation undermines efforts to assess whether the key features of saving are captured by the dynamic lifecycle saving model.

We have made some revisions to the underlying model and experimented with some parameters. We changed the age of economic independence from 21 in our earlier paper, to 25 in this paper, based on a review of the evidence on household headship rates. We have experimented to some degree with the rate of subjective time preference. We have considered variations in the interest rate and the productivity growth rate primarily to assess the impact of these variables. The baseline simulation, however, is based on Taiwan's experience, to the extent that it is documented.

We begin our assessment by comparing the baseline simulation with aggregate saving rates (Figure 6). The simulated saving rates do not closely resemble the actual net national saving rates. There are short-term fluctuations that are unrelated to demographic forces. Persistent differences are more relevant. As compared with the lifecycle simulation, Taiwan was saving too little during the 1950s and early 1960s, too much between 1964 and 1988, and too little during the most recent years. There was no obvious medium-term downturn in the saving rate prior to 1975. The recent decline in saving occurred several decades before the simulated decline and seems not to be associated with demographic factors.

Figure 6. Simulated Baseline saving rate and actual saving rate.

On the positive side, the dynamic lifecycle model does predict a large increase in saving rates (about 14 percentage points) and the level of the simulated saving rate is fairly consistent with actual saving rates.

The differences between the trend in national saving and the lifecycle simulations suggest several possibilities. One is that the parameters employed in the simulation have been incorrectly chosen and that alternative choices would lead to a simulation similar to the one observed in Taiwan. Varying the actual or expected interest rate or productivity growth rate, or adding positive time preference, or altering the intertemporal elasticity of substitution, change the aggregate outcome. Changes in the interest rate and the rate of growth of productivity are explored above. We have also considered the implications of using an elasticity of substitution set at .3 and at 1.0, in contrast to .6 used in the baseline. The resulting level of the saving rate is much lower for .3, and higher for 1.0, but the shape, timing, and magnitudes of the resulting swings in the saving rate remain very similar to the baseline case.

Wider variations could be generated, but we suspect that for reasonable choices, the shape and timing are quite robust, although the levels of the curves do change. The main systematic difference to note is that the effect of population aging on the saving rate in the early to mid 21st century is greater when the productivity growth rate or the interest rate is higher. The interaction between economic growth and saving is a point also made by Mason (1987) and Deaton and Paxson (1998).

At least two difficult aspects of the lifecycle model require more careful attention and could account for some differences between the simulated and actual saving rates observed. The first is the formation of expectations. The simulation results presented here assume that all individuals correctly anticipate changes in demographic variables. If individuals did not anticipate the rapid increase in life expectancy, however, they would save too little as they did in the 1950s. If by the 1970s, there were greater appreciation of the implications of trends in mortality, households would have to save more than simulated to compensate for the inadequate saving of earlier years.

The second issue is the erosion of the family support system discussed extensively above. Low saving rates are sufficient to satisfy lifecycle needs when the elderly rely heavily on their children for economic support. Hence, the rapid increase in saving is very consistent with a shift from a transfer based system to a system of self-reliance combined with purely demographic changes. In a similar vein, the development of public transfer systems in Taiwan in recent years might account for the downturn in national saving.

A final possible explanation for the divergence between trends in saving and the lifecycle simulation is that demographic factors and lifecycle motives do not account for many of the important changes in saving. The purpose of the simulation is to assess the impact of demographic factors not to provide a complete and comprehensive model of saving. We will return to this issue below when we compare the simulation with other available estimates of the impact of demographic factors.

To this point our attention has been directed at aggregate saving, but the simulation model provides detailed age data that can be used to construct cross-sectional or longitudinal age-profiles of income, consumption, and saving. Comparing these profiles to data available for Taiwan provides another check on the consistency of the simulation with actual Taiwan data. Before we do so there are some important technical problems that arise with the use of survey data. The first is that household surveys provide a narrow measure of saving and wealth. Excluded, for example, are the employers' contributions to employee pension funds. Second, consumption and saving are household concepts and empirical profiles are constructed by age of the household head. As is well-known, selectivity problems may mask age-variation that is consistent with the lifecycle model. The age at which young adults establish a separate household may be influenced by unobserved factors that also influence the accumulation of wealth. Likewise, the age at which older adults become members of households headed by their offspring may be influenced by conditions that also bear on wealth. Under these circumstances, the saving and wealth of households may differ substantially from the saving and wealth of individuals.

Figure 7 compares the age-saving profile from survey data for 1976-90, household saving by age of household head, to the simulated age-saving profile for the same period. At most ages, the simulated profile is lower than the actual. The actual and the simulated profiles both have a distinctive M shape. The dip in the middle-ages corresponds to a rise in dependency relative to household income at those same ages (Mason and Miller, 1998). The dip is more pronounced in the simulation than in the survey. Saving rates in the survey are higher than in the simulation among both young and old households. Saving behavior among the elderly has often been an issue raised in debates over the merits of the lifecycle model. Typically, saving by age of household head drops more slowly than saving by age of individual as implied by the lifecycle saving model. As discussed above, however, selectivity problems make it difficult to interpret the age-patterns of saving at both the younger and older ages. Thus, the high rate of saving among households with young and old household heads does not provide clear evidence about the applicability of the lifecycle model to Taiwan. (See Hurd, 1997 for a recent review of these issues.)

Figure 7. Household Age-Specific Savings Rates: Actual and Baseline Simulation

Results presented in Figure 8 address a recent criticism of the lifecycle saving model. Empirical studies show that consumption tracks income quite closely (Carroll and Summers, 1991; Paxson, 1996) while the standard lifecycle model assumes that the path of consumption is independent of current income (except in so far as it affects total lifetime income). Attanasio considers this issue in his research and shows that demographic factors and uncertainty can also lead to tracking. We examine this issue with respect to our simulation model by duplicating a figure in Deaton and Paxson (1997:104), except that theirs is based on an analysis of survey data, and ours is based on an analysis of simulated data, for the same period. The plot shows the estimated age effects from regressions of the logarithm of consumption and of income on age and cohort, normalized to 0 at age 25. Theirs included restricted year effects to capture short-term fluctuations. We do not include these restrictions as our simulations are not

influenced by short-term fluctuations.). Visual comparison suggests that the two plots are very similar indeed, although not identical. The plots show the logarithm of income rising by the same amount (no surprise there; that's in the data), and consumption rising by less, and leveling out well below income in the later years. In the simulation, this leveling of consumption occurs in the mid to late 40's, reflecting declines in household size, while in the survey data it occurs a few years later. Given that the simulations do not include co-resident elderly, this difference is not surprising. Deaton and Paxson interpret their plot (together with others for other countries) as showing that "consumption 'tracks' income over the life cycle" which they say is "difficult to reconcile with the simple life cycle model" (1997:103). In the case of Taiwan, however, our life cycle model incorporating demography generates very similar trajectories. (Note, however, that after age 69, when the last 25 year old child has left home, our simulated trajectory resumes its increase at an exponential rate equal to the interest rate times the elasticity of substitution, or in our case $.6 \times .075 = .045$; we truncated the plot at age 70. It appears from the Deaton and Paxson panel in the figure that consumption in their estimates would decline rather than rise. Also, we simulate single adult households rather than adult couples. With couples, mortality would continue to reduce household size after children's departure.)

Figure 8. Comparison of age effects in Deaton and Paxson analysis with ours.

The final analysis presented here returns to an issue raised in the first section of this paper – the disparate estimates of the impact of population factors on saving. We consider two recent estimates of the impact of demography on saving in Taiwan in light of our detailed simulations. The two studies, Williamson and Higgins, 1997 and Deaton and Paxson, this volume, take very different approaches to analyzing the impact of changing demography and come to quite different conclusions. Williamson and Higgins (1998) analyze pooled cross-section, time-series aggregate saving data using an overlapping generations model to capture some of the dynamic aspects of the lifecycle framework modeled here. Their econometric results are quite similar to the simulation results presented here. They find that rising child dependency depressed saving until around 1970. Subsequently, demographic changes produce a very large swing in saving that is comparable in magnitude to our simulation results.

Deaton and Paxson (this volume) employ a very different approach. Relying on the National Family Income and Expenditure survey they construct age profiles of consumption, income, and saving. They hold these profiles constant as implied by the lifecycle model and determine how changes in age-structure will influence aggregate household saving. In an earlier analysis, Deaton and Paxson (1997) found that demographic change essentially had no impact. The more recent analysis presented here deals with several technical issues that arise in their earlier work, concluding that demographic change has a modest effect on saving. Although the changes are decidedly more attenuated than in Williamson and Higgins or our simulations, the pattern is somewhat similar. They find that demographic change leads to a dip in saving in the late 1960s, a few years earlier than in WH or our simulations. Saving rises subsequently, reaching a peak in about the same year as the simulations. The swing from trough to peak is 5-7 percentage points (depending on the scenario), much smaller than the rise in

the other two analyses, but far from inconsequential. They anticipate a decline in saving that is either large or very large depending on the future rate of productivity growth.

Figure 9. Comparison of WH, DP, and LMM.

Reconciling these studies would greatly increase confidence about the size of the impact of demography on saving. Our simulations show that under a particular set of circumstances the impact of demography on saving could be as great as estimated by Williamson and Higgins. But given a sufficiently strong transfer system, either family or public, demographic changes would have a considerably smaller impact than in our simulations. Thus, one could not conclude that Deaton and Paxson's results are inconsistent with our analysis here.

In part, the results can be reconciled by taking definitional differences into account. Williamson and Higgins analyzes a very broad measure of saving, gross national saving rates, that takes on larger values and might be expected to vary more, in percentage point terms, than net saving or household saving. Deaton and Paxson's measure of saving is narrower and excludes some components of retirement saving making it less sensitive to demographic changes. However, definitional differences almost surely do not account for all of the differences apparent in Figure 9.

An additional feature of the Deaton and Paxson analysis may have a particularly important bearing on the difference between their results and those in our simulation. They do not incorporate the impact of changing life-expectancy on saving profiles. Nor do they consider the impact of differences in lifetime childbearing across cohorts. In Deaton and Paxson (1997) they find large cohort effects (later born cohorts have substantially higher saving rates than earlier born cohorts), but they attribute these to non-demographic factors. If we replicate their statistical analysis using our simulated data, we find very similar cohort effects caused by changes in demographic variables. Our simulated saving rates rise much more rapidly than those in Deaton and Paxson in part because of these cohort effects. In Deaton and Paxson (this volume) the cohort effects are constrained to zero. Again this has the effect of excluding from consideration the long-term trends in life-expectancy and lifetime childbearing. In short, we believe that a more complete accounting would lead one to conclude that demographic factors have a greater impact on saving.

Conclusions

Certain features of household survey data on consumption, earnings and savings have been thought to be inconsistent with life cycle saving behavior. One part of this paper considered this issue, and we found that our simulated household behavior was consistent with survey data in some important respects. For example, both our simulations and the survey data exhibit a strong double humped pattern in saving rates by age in a given year. Simulated life cycle earning and consumption age profiles for cohorts are similar to those from surveys, exhibiting powerful "tracking". As in cross-sectional survey data, consumption does not vary widely across households with different age heads, although it

does vary strongly across cohorts holding age fixed. It is striking that the simulated effects of demographic change over the transition on saving rates for Taiwan are qualitatively similar (timing and direction of fluctuations) for several completely different methods: micro analysis of survey data, macro analysis of cross-national data, and our micro-based macro simulation. However, the simulation based on analysis of survey data shows swings of very much smaller magnitude than the other approaches. This may be because certain potential demographic effects are not included in this survey based simulation, or it may reflect the importance of transfers as a substitute for savings, and of non-life cycle motivations for savings. Our general conclusion is that the life cycle saving simulations generate results that coincide with survey data to a surprising degree.

Another part of the paper considered how the demographic transition in Taiwan would affect aggregate savings under the assumption of pure life cycle saving. Comparing pre- and post- transition stationary states, the demand for wealth increases substantially and permanently over the transition. A concurrent move from familial transfers to individual responsibility for old age (or funded pension systems) would translate this into increased capital per worker, and amplify it. Under life cycle saving, this increase in the demand for wealth is met by a transitory but substantial increase in the saving rate during the stage in the transition when the total dependency rate is falling. In the presence of productivity growth, savings would be higher after the transition than before, otherwise not.

People now live two or three times as long as in the past, but the role of mortality decline for savings has been largely ignored. Declining mortality could explain a large part of increased savings even with no change in population age distribution, and even with no age-variation in saving rates. It is possible, of course, that instead of saving more, people faced with longer life would choose to postpone retirement, in which case mortality decline would have less if any effect on saving. But to this point in the history of the industrial populations, the trend in retirement age has been strongly downward even as longevity has increased. We find, as do Deaton and Paxson, that population aging in Taiwan after 2010 will reduce saving rates, with a larger decline when productivity growth rates are slower, illustrating the interaction of growth rates and demography.

Because life cycle saving behavior should depend on expectations about mortality, productivity growth, and interest rates in the distant future, it is very difficult to test based on current data. At the aggregate level, regressions of saving rates on current population age distributions could in principle be misleading. We also find no necessary relationship of population growth rates to saving rates during the transition; sometimes they move in the same direction, sometimes in opposite directions. Nor is there any necessary relationship of population growth rates to savings rates across steady states; the association depends on the cause of variation in growth rates. In any event, these steady state results are not useful for thinking about changes during the transition.

Despite some success in duplicating certain key patterns observed in survey data, we have important reservations about the life cycle saving model. One concerns the steep rise in consumption with age in our simulations and in the actual survey data. Simulated young adults do not typically borrow heavily against expected high future earnings so as

to be able consume more evenly over their life cycles, even when they are not liquidity-constrained in the model. One reason is that we assume that young adults live with their parents until age 25, which actually understates the length of their co-residence according to the survey data. More importantly, however, in the model their planned life cycle consumption trajectories are very steep in response to high interest rates. This is why the young, with much higher life time earnings, consume about the same amount as the concurrent elderly, who have much lower life time earnings. The longitudinal and cross-sectional implications of the simulation are empirically realistic (see above). However, it is doubtful that consumption and saving behavior are so strongly influenced by interest rates, since the empirical literature suggests that behavior is relatively insensitive to interest rate variations. We would like to experiment with non-standard models that contain elements of life cycle saving, but which build on simpler "rule of thumb" specifications, modified by demographic factors. One such model we have examined assumes that households save a fixed proportion of income throughout their lives until "retirement", with the amount set to provide a retirement income equal to 70% of their average income in the preceding five years. In this setup, the presence of children has no effect on saving behavior (contrary to reality), but there is still a substantial effect of the demographic transition on saving rates and wealth due to longer life and the changing age distribution of household heads.

We have shown that the demographic transition, operating through the life cycle saving motive, is capable of accounting for a substantial rise in saving rates, and for very high levels of savings rates, in Taiwan. The simulations do not fit the timing of changes well, and they predict an early decline in savings rates in the 1950s and 1960s that was not observed. The levels and expected changes in familial transfers must surely play an important role in the explanation of savings in Taiwan, and we have not yet examined this possibility systematically. Other influences on saving, such as buffering against uncertainty of income streams, preparing for intended bequests, or slowly changing consumption habits, must also play a role. We do believe that life cycle saving is an important part of this picture, and that through life cycle saving, the massive demographic changes over the course of the demographic transition have influenced savings behavior and wealth accumulation, and will continue to do so in the future.

Appendix

Details of this model can be found in the appendices to Lee, Mason and Miller (1997). Here we begin by describing a few elements of the model for the static case.

When a household is formed, the heads seek to maximize life time utility V :

$$V = \int_z^\omega e^{-\rho x} u[C(x), H(x)] dx$$

where z is the age of forming a household, ω is oldest age with non-zero survival probability; $C(x)$ is total household consumption at age x ; $H(x)$ is total household size measured in equivalent adult consumer units (EAC), and ρ is the discount rate.

The instantaneous household utility function in V is specified as:

$$u[C(x), H(x)] = H(x) \left(\left(\left[\frac{C(x)}{H(x)} \right]^{1-\gamma} - 1 \right) / (1-\gamma) \right)$$

where γ is the inverse of the intertemporal elasticity of substitution.

In this specification, household utility is proportional to the number of Equivalent Adult Consumers (EACs) in the household, denoted $H(x)$, times a standard constant relative risk aversion utility function, with consumption per EAC as its argument. This is a natural generalization of Tobin's household utility function. It has been suggested that it is wrong to multiply the parenthetical quantity on the right by $H(x)$, because $H(x)$ gives less weight to consumption by children than by adults, due to their lower EAC weight. We believe this specification is appropriate, however, since if $H(x)$ were replaced by the number of household members, giving children the same unitary weight as adults, then optimization would lead parents to try to squeeze higher consumption per EAC into years in which children were present, since children become super-efficient producers of household utility. This contradicts empirical reality.

Life cycle utility is maximized subject to the constraint that the present value of expected future life time earnings of householders, and their children while co-resident ($PV(YI)$), evaluated when the heads are age z , equals the present value of expected future household consumption. Both expectations are survival weighted. The maximization yields the following planned age-time path for household consumption:

$$C(x) = \frac{H(x) PV[YI] e^{(r-\rho)x/\gamma}}{\int_z^\omega e^{-ra} H(a) e^{-(r-\rho)a/\gamma} da}$$

It follows that the life cycle trajectory of consumption per EAC rises at the rate $(r-\rho)/\gamma$, where γ is the inverse of the intertemporal elasticity of substitution.

The extension to a context of economic and demographic change is based on rules for formulating expectations as circumstances change, and then on reoptimization at each

age, based on the initial situation that results from earlier decisions. Reoptimization is necessary because circumstances change in unexpected ways. We assume that every decision is made under complete certainty about the future, despite the fact that householders are repeatedly surprised as the future unfolds, which is an inconsistency on our part.

In our current implementation of the dynamic model, actors are fully aware of future demographic change. Therefore, their only source of uncertainty is future economic change reflected in productivity rates and interest rates. Actors form their life cycle plans based on their expectation of future productivity rates and interest rates which turn out to be incorrect. Each year, they must form new life cycle plans since their current circumstances are different than what they had foreseen.

The dynamic version of the age-time path of consumption is listed below. It differs from the static version in that optimization occurs at all ages $x \geq z$ rather than solely at age $x = z$ and that these optimizations are based on expectations about future interest rate $[r^*(t)]$ and productivity growth rates [which are reflected in Y_l^*]. Consumption is optimized at age x looking forward y years ($y \geq 0$) into the future when the household head will be aged $x+y$ in year $t+y$. In the dynamic equation, the value of future life time wealth must include both expected future earnings (as in the static model) and current wealth that reflects the accumulation of past savings. Wealth $[W(x,t)]$ is defined so that cohort wealth is maintained. That is, there are lateral, not vertical, bequests – wealth saved by last year's households aged $x-1$ is shared among this year's surviving heads aged x .

$$C(x, y, t) = \frac{H(x, y, t) [W(x, t) + PV[Y_l^*(x, y, t)] e^{(r^*(t) - \rho)y/\gamma}]}{\int_0^{\omega-x} e^{-r^*(t)y} H(x, y, t) e^{-(r^*(t) - \rho)y/\gamma} dy}$$

In the special case in which household expectations about future interest rates and productivity rates turned out to be correct, households would have no need to re-evaluate their age-time path of consumption. Households would only need to make one optimization decision at age z (and the dynamic equation simply reduces to the static equation). This special case is the alternative simulation reported in Figures 3 and 4 in which interest rates and productivity rates are fixed and households correctly foresee these rates.

REFERENCES

Adams, N. (1971) "Dependency rates and savings rates: comment: American Economic Review 61: 472-475.

Attanasio, Orazio P., James Banks, Costas Meghir, and Guglielmo Weber (1997) "Humps and Bumps in Lifetime Consumption", unpublished paper of University College London, Institute for Fiscal Studies and NBER.

Bilsborrow, R.E. (1979) "Age distribution and savings rates in less developed countries" Economic Development and Cultural Change 28: 23-45.

Bilsborrow, R.E. (1980) "Dependency rates and aggregate savings rates revisited: corrections, further analysis, and recommendations for the future" in J.L. Simon, and J. DaVanzo, eds., Research in Population Economics 2 (Greenwich, Conn.: JAI Press) 183-204.

Carroll, Christopher D. and Lawrence H. Summers (1991) "Consumption Growth Parallels Income Growth: Some New Evidence," in Bernheim, B. Douglas and John B. Shoven, eds., National Saving and Economic Performance, A National Bureau of Economic Research Project Report (Chicago: The University of Chicago Press) 305-343.

Coale, Ansley and Edgar M. Hoover (1958) Population Growth and Economic Development in Low-income Countries: A Case Study of India (Princeton: Princeton University Press).

Deaton, Angus S. and Christina H. Paxson (1997) "The Effects of Economic and Population Growth on National Saving and Inequality," Demography 34(1) (February) 97-114.

Deaton, Angus and Christina Paxson (1998) "Growth, Demographic Structure, and National Saving in Taiwan," Population and Development Review, this volume.

Fisher, Irving, 1930, The theory of interest as determined by impatience to spend income and opportunity to invest it. (New York: The Macmillan Company).

Feeney, Griffith and Andrew Mason (1998) "Population in East Asia" East-West Center Working Papers: Population Series, 88-2 Honolulu, HI.

Fry, Maxwell J. and Andrew Mason (1993) "The variable rate of growth effect in the life cycle saving model," Economic Enquiry 20 (July) 426-442.

Goldberger, A. (1973) "Dependency rates and savings rates: comment" American Economic Review 62: 232-233.

Gupta, K.L. (1971) "Dependency Rates and savings rates: comment" American Economic Review 61: 496-671.

Higgins, Matthew D. 1994. The Demographic Determinants of Savings, Investment and International Capital Flows. PhD Dissertation Thesis, Harvard University.

Hurd, Michael D. 1997. "The Economics of Individual Aging" in Mark R. Rosenzweig and Oded Stark, eds. Handbook of Population and Family Economics, Volume 1B (Amsterdam: Elsevier) 892-966.

Kelley, Allen C. (1988) "Population Pressures, Saving, and Investment in the Third World: Some Puzzles," *Economic Development and Cultural Change* 36, 3 (April) 449-464.

Kelley, Allen C. and R.M. Schmidt (1996) "Saving, Dependency and Development" *Journal of Population Economics* v.9 n.4, pp.365-386.

Lee, Ronald, Andrew Mason and Timothy Miller (1997) "Saving, Wealth, and the Demographic Transition in East Asia" East-West Center Working Papers: Population Series, 88-7 Honolulu, HI.

Lee, Ronald, Andrew Mason, and Tim Miller (1998). "Saving, Wealth, and Population." Paper presented at the Symposium on Population Change and Economic Development, Bellagio Center, Lake Como, Italy, November 1998.

Lee, Ronald, Andrew Mason, and Tim Miller (forthcoming). "Reply", in Andrew Mason, Tom Merrick, and Paul Shaw, eds., *Macroeconomics and Population Momentum* (Washington, D.C.: The World Bank).

Leff, Nathaniel H. (1969) "Dependency rates and savings rates," *American Economic Review* 59 (December 1969) 886-895.

Leff, Nathaniel H. (1980) "Dependency Rates and Savings Rates: A New Look," in Julian Simon, ed., *Research in Population Economics* 2 (Greenwich, Conn.: JAI Press) 205-214.

Leff, Nathaniel H. (1984) "Dependency Rates and Savings Rates: Another Look," *The American Economic Review* 74 (March) 231-233.

Mason, Andrew (1981) "An Extension of the Life-cycle Model and its Application to Population Growth and Aggregate Saving," *East-West Population Institute Working Papers* 4 (January).

Mason, Andrew (1987) "National Saving Rates and Population Growth: A New Model and New Evidence," in D. Gale Johnson and Ronald D. Lee, eds., *Population Growth and Economic Development: Issues and Evidence*, (Madison: University of Wisconsin Press) 523-560.

- Mason, Andrew (1988) "Saving, Economic Growth, and Demographic Change," *Population and Development Review* 14 (March) 113-144.
- Mason, Andrew et al. 1993. "Domestic Resource Mobilization: Analysis of Survey Data" in Campbell, Burnham et al., eds. *The Economic Impact of Demographic Change in Thailand, 1980-2015*. (Honolulu: East-West Center) 115-143.
- Mason, Andrew and Tim Miller (1998) "Family and Intergenerational Income Transfers in Taiwan," in K.O. Mason et al., eds. *The Changing Family in Comparative Perspective: Asia and the United States* (Honolulu: East-West Center) 215-236.
- Modigliani, Franco and Albert Ando (1957) "Test of the Life Cycle Hypothesis of Saving," *Bulletin of the Oxford University Institute of Statistics* 19 (May) 99-124.
- Ogaki, Masao, Jonathan Ostry and Carmen Reinhart (1996) "Saving Behavior in Low- and Middle-Income Developing Countries: A Comparison" *International Monetary Fund Staff Papers*, v.43 n.1 (March).
- Ogawa, Naohiro and Robert D. Retherford, 1993. "Care of the Elderly in Japan: Changing Norms and Expectations," *Journal of Marriage and the Family*, 55(3) (August) 585-597.
- Paxson, Christina (1996) "Saving and Growth: Evidence from Micro Data," *European Economic Review*, v.40 pp.255-88.
- Ram, Rati (1982) "Dependency Rates and Aggregate Savings: A New International Cross-Section Study," *American Economic Review* 72 (June) 537-544.
- Ram, Rati (1984) "Dependency Rates and Savings: Reply," *American Economic Review* 74 (March) 234-237.
- Tobin, James (1967) "Life cycle saving and balanced economic growth," in William Fellner, ed., *Ten Economic Studies in the Tradition of Irving Fisher* (New York: Wiley Press) 231-256.
- Weil, N. David. 1994. "The Saving of the Elderly in Micro and Macro Data," *The Quarterly Journal of Economics* 109 (1) 55-81.
- Weinstein, W., T. H. Sun, M. C. Chang and R. Freedman, 1994. "Co-Residence and Other Ties Linking Couples and their Parents," in Arland Thornton and Hui-Li Sheng Lin, *Social Change & the Family in Taiwan* (Chicago: The University of Chicago Press).
- Williamson, Jeffrey and Matthew Higgins (1997) "The Accumulation and Demography Connection in East Asia." *Conference on Population and the Asian Economic Miracle*. East-West Center, Honolulu, Hawaii, January 7-10. In press.