The Effects of Adult Longevity on Saving

Tomoko Kinugasa
Assistant Professor
Graduate School of Economics
Kobe University
2-1 Rokkodai-cho Nada-ku Kobe, Japan 657-8501
Email: kinugasa@econ.kobe-u.ac.jp.

and

Andrew Mason
Professor of Economics
University of Hawaii at Manoa
2424 Maile Way Saunders Hall Room 542
Honolulu, Hawaii, U.S.A. 96822
Senior Fellow, East-West Center
Email: amason@hawaii.edu

Abstract

Many countries experienced a remarkable increase in life expectancy during the 20th century, but the development implications have received only modest attention. We analyze steady state and out-of-steady-state effects of the transition in adult longevity on the national saving rate using an overlapping generations model. We show that the national saving rate depends on both the level and rate of change in adult survival. Countries with rapid transitions have particularly elevated saving rates. Empirical evidence is drawn from two sources: long-term historical trends for a small number of countries and world panel data for 1960-95. Two important conclusions are supported by the empirical analysis. First, the demographic transition had a large positive effect on aggregate saving, but over three-quarters of the gain was due to improvements in old-age survival rather than declines in youth dependency. Second, population aging will not lead to a decline in aggregate saving rates. The compositional effect – lower saving rates among the elderly – is dominated by the behavioral effect – individuals will save more to provide for a longer old age.

1.Introduction

Previous research has emphasized two channels through which the demographic transition may influence the accumulation of wealth. First, the transition produces changes in age structure that will have compositional effects if saving rates vary by age. Second, changes in demographic variables may influence behavior. Because children consume more than they produce, an increase in their relative numbers should depress saving rates. During the earliest part of the demographic transition, the decline in infant and child mortality led to rapid growth in the number of children and a rise in child dependency. Later, as fertility begins to decline, the share of children in the population begins to decline. In the absence of offsetting behavioral change, compositional effects should lead, first, to a decline and, then, to a rise in saving rates. The final stages of the transition are dominated by population aging. Like children, the elderly consume more than they produce and, hence, the rise in old-age dependency is anticipated to lead to a decline in aggregate saving (Kelley and Schmidt 1996; Higgins and Williamson 1997).

Empirical research has supports the hypothesis that a decline in the share of the dependent population, the child dependent population in particular, leads to higher saving rates. The magnitude of compositional effects, however, is a controversial and important empirical issue. The controversy is particularly salient in light of East Asia's successful development experience. Large increases in aggregate saving rates, leading to rapid capital accumulation, is widely recognized as one the key ingredients to the region's success. Several recent empirical studies, based on the analysis of aggregate cross-national panel data, have identified changes in age structure as the most important or perhaps even the exclusive reason why aggregate saving rates increased (Higgins 1994; Kelley and Schmidt 1996; Higgins and Williamson 1997; Williamson and Higgins 2001).

An alternative approach, employed by Deaton and Paxson (2000), reaches very different conclusions. They use a series of consumer expenditure surveys from Taiwan to estimate individual age profiles of consumption and earning. They combine these estimated profiles with observed and projected changes in age structure to simulate aggregate saving rates over Taiwan's demographic transition. They conclude that changes in age structure had modest effects on saving rates and can not explain the dramatic increase in aggregate saving rates in Taiwan.

One possible resolution of this empirical controversy is that the changes in fertility and mortality have behavioral, as well as, compositional effects. Many possibilities have been discussed in the literature about ways that mortality and fertility decline may influence consumption and income profiles. The quality – quantity tradeoff may lead to a rise in consumption per child. Labor force behavior varies with fertility. Expectations about old-age support – either from public or familial systems – may shift in anticipation of changes in age structure. The decline in adult mortality may influence saving by affecting the expected duration of retirement. It is the last possibility that is explored in this paper.

The effect of mortality on saving has been explored in a number of previous studies (Yaari 1965; Davies 1981; Zilcha and Friedman 1985; Cutler, Poterba et al. 1990; Kuehlwein 1993; Leung 1994; Borsch-Supan 1996; Schieber and Shoven 1996; Bloom, Canning et al. 2003; Kageyama 2003). Our interest was stimulated in particular by recent simulation results that show that increases in life expectancy can have large effects on aggregate saving if household saving is governed by the lifecycle model (Lee, Mason et al. 2000; 2001a; 2001b).

Much of the previous research on saving has been based on steady-state models that do not adequately capture the swings in age structure that characterize countries in the midst of their demographic transitions. Higgins made an important theoretical contribution by using a simple OLG model to capture the dynamic effects of changes in fertility. His approach has influenced our own theoretical approach, summarized in Section 2 and described in detail in Kinugasa (2004). We extend the steady-state variable rate-of-growth model, developed by Mason (1981; 1987; 1988) to a non-steady-state world. The result is a distinctive empirical specification in which aggregate saving depends on the level of adult mortality, interacted with the rate of economic growth, and the rate at which adult mortality is declining.

In Sections 3 and 4 of the paper, we explore the evidence drawing on two different approaches. Section 3 takes an historical perspective by looking at data for seven countries for which we can track all or a substantial part of the entire demographic transition. We show a distinctive pattern of adult mortality for the sub-group of Asian countries as compared with the countries from the West. The Asian countries began their mortality transitions later, went through a catch-up period when adult mortality declined rapidly, followed by a period of steady increase at a rate similar to that found in the West. The difference in the demographic transitions between the West and East Asia offers a useful opportunity to test our model. The trends in saving rates are broadly consistent with the model. In particular, rapid mortality increase is associated with higher saving rates.

In Section 4, we estimate the saving model using aggregate cross-national data. The evidence is consistent and robust in its support of the hypothesis that an increase in old-age survival leads to higher saving rates. In a sub-sample consisting of Western and East Asian countries, the rate of increase in old-age survival also has a positive effect on saving. In other parts of the developing world, however, we find no evidence that the rate of change in old-age survival has an effect on saving. Why different patterns persist is an issue we continue to explore. The compositional effects of changes in age structure are much weaker once old-age survival is controlled. The youth dependency ratio is statistically significant in the West/East Asia sample only and its effect is more modest than found in other recent empirical studies employing cross-national evidence. The gap between empirical analysis based on household survey data and aggregate cross-national data is thus narrowed.

2. Theoretical Background

Changes in adult survival influence aggregate saving in two ways. First, as the survival rate increases the expected duration of retirement rises. Thus, individuals will consume less and save more during their working years in order to support more expected years of consumption during retirement. Second, increases in the adult survival rate lead to an increase in the share of retirees in the adult population. Given that retirees are saving at a lower rate than workers, the compositional effect of an increase in adult survival is to reduce aggregate saving. What is the net effect on improvements in adult survival on aggregate saving?

Providing a clear answer to this question requires a careful examination of the dynamics in addition to the comparison of steady states. We consider two different approaches to the dynamics. First, we consider the effect of a one-time increase in survival on saving rates during the current and subsequent period. Second, we consider the how saving rates are influenced by steady increases in survival at varying rates. As will be shown in the empirical section, considering these alternatives brings a clearer understanding of the mortality transition as it has actually evolved.

This model considers a population consisting of two generations of adults. Each person lives for up to two periods – the first period as a working, prime-age adult and the second period as a retiree. All individuals survive their working period, and q_t survive to the end of their retirement period. The remainder ($1-q_t$) die at the end of the first period of life. Thus, q_t is both the probability of reaching retirement age and the expected years (at birth) lived during retirement. Individuals cannot foresee whether they will survive, but they know the value of q_t for the population. Costless annuities are available so that individuals protect themselves against longevity risk by purchasing an annuity. Individuals know the interest rate that the annuity will pay.

The consumer's optimization problem is to maximize lifetime utility, assuming constant relative risk aversion, $V_t = \frac{c_{1,t}^{1-\theta}}{1-\theta} + \delta q_t \frac{c_{2,t+1}^{1-\theta}}{1-\theta}$, given the lifetime budget constraint: $w_t A_t = c_{1,t} + \frac{q_t}{1+r_{t+1}} c_{2,t+1}$; $c_{1,t}$ is consumption while a prime-age adult and $c_{2,t+1}$ is consumption while elderly; δ is the discount factor, defined as $\delta = 1/(1+\rho)$, where ρ is the discount rate; $1/\theta$ is the intertemporal elasticity of substitution; r_{t+1} is the interest rate; A_t is labor-augmenting technology; and w_t is the wage per unit of effective labor.

Kinugasa (2004) shows that the per capita savings of prime-age adults and retirees are:

$$\begin{aligned} s_{1,t} &= \Psi_t A_t w_t = \frac{q_t \delta^{\frac{1}{\theta}} A_t w_t}{q_t \delta^{\frac{1}{\theta}} + (1+r_{t+1})^{\frac{\theta-1}{\theta}}} \\ s_{2,t} &= -s_{1,t-1} = -\Psi_{t-1} A_{t-1} w_{t-1} = \frac{q_{t-1} \delta^{\frac{1}{\theta}} A_{t-1} w_{t-1}}{q_{t-1} \delta^{\frac{1}{\theta}} + (1+r_t)^{\frac{\theta-1}{\theta}}} \end{aligned} \qquad (1)$$

where Ψ_t is the share in wage income of saving by prime-age adults. An increase in the adult survival rate has an unambiguous positive effect on Ψ_t and, hence, on per capita saving by prime age adults. An increase in the adult survival rate has an unambiguous negative effect on per capita saving by retirees. The response of aggregate saving to changes in survival depends on additional features of the macro-economy.

Gross domestic product (Y_t) is produced by a Cobb-Douglas production function with labor-augmenting technological growth, i.e., $Y_t = K_t^{\phi} L_t^{1-\phi}$, where ϕ is the share of capital in GDP, $0 < \phi < 1$. $L_t = A_t N_{1,t}$ is the aggregate labor supply measured in efficiency units. $N_{1,t}$ is the population of prime-age adults and A_t is the technology index. The population growth rate per generation is $n-1$ and, hence, $N_{2,t} = N_{1,t}/n$. The technological growth rate per generation is $g-1$. Hence, the relationship between the total lifetime labor income of prime-age adults and pensioners is given by $w_{t-1} A_{t-1} N_{2,t} = w_t A_t N_{1,t} / gn$. Using lower case letters to represent quantities per unit of effective worker, output per effective worker can be expressed as $y_t = k_t^{\phi}$ and the capital output ratio is equal to $k_t^{\phi-1}$. The depreciation rate (ξ) is assumed to be constant; hence, depreciation as a share of GDP is equal to $\xi k_t^{\phi-1}$.

Total gross national saving is the sum of the saving of adults ($S_{1,t}$), the saving of the elderly ($S_{2,t}$) and depreciation (ξK_t). Dividing by Y_t yields the gross national saving rate at time t:

$$\frac{S_t}{Y_t} = (1-\phi)\left(\Psi(q_t, k_t) - \Psi(q_{t-1}, k_{t-1})\frac{1}{gn}\right) + \xi k_t^{1-\phi} \qquad (2)$$

The term $(1-\phi)$ is the share of labor income in GNP, $\Psi_t(q_t, k_t)$ is saving by current workers as a share of current labor income, $-\Psi(q_{t-1}, k_{t-1})\frac{1}{gn}$ is saving by current retirees as a share of current labor income, and $\xi k_t^{1-\phi}$ is depreciation as a share of current GNP.

RESULTS

The steady-state gross national saving rate is:

$$\left(\frac{S}{Y}\right)^{*} = (1-\phi)\Psi(q^{*}, k^{*})\left(\frac{gn-1}{gn}\right) + \xi k^{*1-\phi} \qquad (3)$$

where the * superscript denotes equilibrium values. Several properties of the lifecycle saving model follow from equation (3). First, saving rate net of depreciation is zero if the economy is not growing (*gn=1*). This is a standard and well-known implication of the lifecycle model (Modigliani and Brumberg 1954). Second, an increase in the rate of growth has an effect on the national saving rate. As in the variable rate-of-growth model (Mason (1981,1987) and Fry and Mason (1982)), the partial effect of an increase in GDP growth rate is the mean age of earning less the mean age of consumption. As shown in Kinugasa, an increase in the survival rate leads an increase in mean age of consumption, but mean age of earning is fixed. ψ is the difference between the mean ages.[1]

The effect of changes in adult survival on saving depends on whether or not the capital-labor ratio and interest rates are endogenous. In a small open economy, the equilibrium capital-labor ratio and interest rates are determined by global economic conditions. A rise in domestic saving – and factors that influence the saving rate – will have no effect on domestic investment nor on domestic interest rates. In a closed economy, saving and investment are equal and the rate of interest is endogenously determined by the interplay of the supply of capital by household and the demand for capital by firms. The effect on saving of an increase in adult survival in each of these environments is considered in turn.

Saving in a Small Open Economy

The effect of an increase in adult survival on the steady state saving rate in a small open economy depends on the rate of growth of income. If the economy is growing, $gn>1$, the steady state saving rate rises with adult survival. In an economy with negative economic growth, the steady state saving rates decline with adult survival. The steady state saving rate given by equation (3) holds with k^* exogenously determined. An increase in adult survival leads to a rise in the share of labor income saved by prime age adults, i.e., $\partial\Psi^* / \partial q^* > 0$. The saving by prime age adults is greater, but the dis-saving by retirees is greater, as well. In a growing economy, the increase in saving by prime age adults dominates the decline in saving by retirees and the aggregate saving rate rises with adult survival. In a declining economy, the decline in saving by retirees dominates and the aggregate saving rate declines as adult survival rises.

Of greater interest is the response of saving rates in a more dynamic context, characterized in a small open economy by setting $k_{t-1} = k_t = k^*$ in equation (2). Consider an anticipated increase in the survival rate at time *t.* Prime age adults respond by increasing their saving rates. Saving by retirees are unaffected by changes in the probability that the current generation of prime age adults will survive to reach retirement. Thus, the aggregate saving rate rises in period *t.* An important feature of equation (2) is that the effect of an increase in prime age adults on aggregate saving in period *t* does not depend on the rate of economic growth *gn.* In period *t+1,* dis-saving by retirees rise and aggregate saving rates decline. In the absence of further changes in survival, a new equilibrium saving rate is established in period *t+1.* In a growing

---

[1] In this model, the mean age of consumption is $(c_{1,t} + 2q_t c_{2,t+1})/(c_{1,t} + q_t c_{2,t+1})$ and the mean age of earning is 1.

economy, the new equilibrium will be higher than the rate of saving in period *t-1,* but lower than saving in period *t.*

Saving in a Closed Economy

In a closed economy, an increase in the saving rate leads to greater investment, capital deepening, and a decline in the interest rate. Thus, the effect on saving of a change in the survival rate depends on the supply and demand for capital.

The supply of capital follows directly from the saving model presented above, because the capital stock in period *t+1* is equal to total saving by prime-age adults in period *t.* Expressed as capital per effective worker, the supply of capital in year *t+1* depends on the wage per effective worker in year *t,* the share of that wage that is saved by prime-age adults, and the rate at which the effective labor force is growing between year *t* and *t+1:*

$$k_{t+1} = \frac{\psi(r_{t+1}, q_t) w_t(k_t)}{gn} = \mathbf{S}_t(\underset{?}{r_{t+1}}, \underset{+}{w_t(k_t)}, \underset{+}{q_t}), \quad (4)$$

where $\mathbf{S}_t$ is the supply function of capital. The effect of the interest rate on the supply of capital is ambiguous, but in the analysis presented here we assume that an increase in the interest rate leads to greater saving.[2] The wage is equal to the marginal product of an effective worker, $w_t = f(k_t) - k_t f'(k_t)$ and rises with capital per effective worker at time *t.* An increase in the survival rate leads to an increase in the share of labor income saved by prime-age adults and, hence, capital per effective worker.

The demand for capital, **D,** is governed by the marginal condition that the cost of capital equals the net return, i.e., $r_{t+1} = f'(k_{t+1}) - \xi$. That $f''<0$ implies that the demand curve is downward sloping. The demand for capital is independent of the survival rate.

The effect of an increase in the survival rate from q^* to q' in period 1 is traced in Figure 1. The demand curve, **DD** , is unaffected by the increase in survival, but the supply curve, **SS**, shifts to the right leading to a rise in capital per worker and wages and a decline in interest rates. The rise in wages and the decline in interest rates induce further shifts in the supply of capital – a process that continues until a new equilibrium is established.[3] Unless the decline in interest rates leads to a substantial increase in consumption by prime-age adults – a possibility not born out by empirical

[2] The results hold unless a rise in interest rates leads to a large increase in saving rates. Empirical evidence does not support a large negative effect, however. For details see Kinugasa 2004.

.

[3] The economy converges in a non-oscillatory pattern to the steady state under plausible parameter values. See Kinugasa (2004) for details.

research – an increase in adult survival in period t leads to capital deepening in period $t+1$ ($\partial k_{t+1} / \partial q_t > 0$) and in equilibrium ($\partial k^* / \partial q > 0$).

The effect of survival on saving in a closed economy is closely related to its effect on capital per effective worker. In a closed economy, the saving rate is:

$$\frac{S_t}{Y_t} = \left(gn \frac{k_{t+1}}{k_t} - 1 + \xi \right) k_t^{1-\phi}. \tag{5}$$

In steady state, the saving rate is:

$$\left(\frac{S}{Y} \right)^* = (gn - 1 + \xi) k^{*1-\phi} \tag{6}$$

From inspection of equation (6) an increase in the equilibrium capital-labor ratio and, hence, the capital-output ratio ($k^{1-\phi}$), leads to an increase in the equilibrium net saving rate ($(gn-1)k^{*1-\phi}$) in a growing economy. Gross saving increases if the depreciation rate plus the rate of growth is positive. During transition, as shown in equation (5), the saving rate is elevated above the equilibrium level depending on the rate of capital deepening.

Figure 2 compares the simulated saving rates in a small open economy and a closed economy produced by an increase in adult survival from 0.4 in year *t-1* to 0.5 in year *t*.[4] The initial impact is large in both cases. The response is somewhat muted in the closed economy because the decline in interest rates lead to reduced saving rates among prime-age adults. A new equilibrium is established in period *t+1* in the open economy, but the adjustment is more gradual in the closed economy as described above. The equilibrium saving rate in the closed economy is greater than in the open economy, because capital deepening in the closed economy leads to greater depreciation and a rise in gross saving relative to net saving.

One would not be likely to observe the simulated saving paths shown in Figure 2 because adult survival trends upward at a relatively constant rate in many countries – as we will show below.

Figure 3 presents simulated saving rates assuming that adult survival increases by 0.1 per period starting from 0.4 in year *t-1*. Otherwise, parameters are identical to

---

[4] Each period consists of 30 years. We assume that population growth and productivity growth are both 1.5 percent per year implying values of n=g=1.563. The discount rate is 0.811, intertemporal elasticity of substitution is 1.3, and depreciation rate is 0.785. The elasticity of output with respect to capital is 1/3. Kinugasa (2004) provides additional details.

those employed in the simulations presented in Figure 2. The onset of adult mortality decline leads to a secular rise in saving rates that continues as long as adult survival rates continue to increase. Saving rates appear to be very nearly linear in adult survival after period *t-1* in the open economy case and after period *t* in the closed economy case.

The simulation results shown in Figure 3 identify a serious empirical challenge to distinguishing the more complex dynamic model from the simpler steady state model. If adult survival is increasing at a steady pace both models imply that saving rises with adult survival. This is a central issue that we address in the empirical section of the paper.

3. Historical Perspectives on Old-Age Survival and Saving

The modern mortality transition began first in the West. Early gains were concentrated at young ages, but by 1900 old-age survival rates were rising steadily in Sweden, the United Kingdom, Italy, and the US – the four Western countries we examine below. The mortality transition began much later outside of the West. The three Asian populations for which we have relatively complete historical data – Japan, Taiwan, and India – did not experience significant gains in old-age survival until the middle of the 20th Century. When the mortality transition began, however, it was very rapid as these Asian countries caught or, in the case of Japan, surpassed the West.

Historical mortality transitions are of great interest here because of their implications for long-run trends in national saving rates. Previous empirical research – and the analysis presented in Section 4 – relies on data that cover a relatively small portion of the mortality transition. This is unfortunate given the long-term nature of the theoretical model. The distinctive experiences of Asia with the West, however, provide an opportunity to assess long-term effects of mortality change on saving.

We begin, however, with a more detailed examination of the mortality transitions of seven countries. In six of the countries – all but India – we are able to construct an old-age survival index (q) that is also used in Section 4.[5] The old-age survival index is the expected years lived after age 60 per expected year lived between the ages of 30 and 60 given the age specific death rates observed during the year of observation. The value of the q ranges from less than 0.2 expected years lived after age

[5] In India we analyze life expectancy at age 30, which is highly correlated with the old-age survival index.

60 per expected year lived between the ages of 30 and 60 in Taiwan *circa* 1900 to close to 0.8 in current day Japan.

Historical data for Sweden allows us to trace the transition in old-age survival from the mid-18th Century. The 250 years of data can be described remarkably well as consisting of a pre-transition period during which old-age survival was virtually stagnant and a transition period during which old-age survival increased more rapidly. In 1751 adults could expect to live about one-third of a year after age 60 for every year lived between the ages of 30 and 60. Between 1761 and 1876 the old-age survival index increased at an annual rate of only 0.0006. Between 1876 and 2001 the old-age survival index increased four times as rapidly - at an annual rate of 0.0026. Allowing for three short-run mortality crises – famine in 1772-73, the Finnish War in 1808-09, and the Spanish flu epidemic of 1918 – a piece-wise linear regression with one break-point at 1876 explains 93 percent of the variance in adult mortality (Table 1).[6]

Table 1. Structural Changes of the Old-Age Survival Index. About here.

The old-age survival transitions of the three other Western countries that we have analyzed can be characterized in equally simple fashion. For the United Kingdom, old-age survival increased at an annual rate of 0.0009 between 1841 and 1900 and at a rate of 0.0024 between 1900 and 1998, with 96 percent of the variance explained by the piece-wise linear model with a single break point. The available data for Italy and the United States do not extend into the pre-transition period. Old-age survival in Italy from 1872 to 2000 and in the United States from 1900 to 2001 can be explained as consisting of a single transition period with old-age survival increasing by 0.0029 years per year in Italy and by 0.0033 years per year in the United States.

That the gains in these four countries have been remarkably constant during the 20th Century has important – and unfortunate – implications for testing the dynamic saving model. In the absence of time series variation in the rate at which old-age survival is increasing, estimates of the effect of the rate of change in old-age survival will depend entirely on cross-country differences. Even though there are small year-to-year fluctuations and instances of more significant fluctuations, e.g., the flu epidemic of 1918, it is doubtful that these fluctuations influenced expectations about the future duration of old-age. In our model, it is expectations that matter. To add to the

---

6 The break points were assigned visually. A more precise iterative approach would improve the fit of the piece-wise linear approximations, but the analysis presented below would not be affected in any important way. .

difficulties, the cross-national differences among the four Western countries are quite modest. The historical experience of the West is useful to the extent that we explore the effect on saving of the shift from pre-transition to transition. We return to this issue below.

Although the mortality transitions in many Western countries were probably similar to those found in Sweden, UK, Italy, and the US, the mortality experience in East Asia is quite distinctive judging from the relatively complete data for Japan and Taiwan. Their pre-transition periods lasted until much later, but were followed by a significant catch-up period during which old-age survival increased quite rapidly. Having closed the mortality gap with the West, the gains in adult mortality have slowed. Mortality gains in Taiwan are similar to those found in the West while Japan continues to experience larger gains in old-age survival (Table 1).

Indian life expectancy at age 30 also increased very gradually until 1951. For the next forty years substantial gains were achieved. The 1990s saw a marked slow-down in India. The pattern is similar to that found in Japan and Taiwan although direct comparison is not possible.

To what extent are the saving trends in these six countries consistent with the predictions of our saving model? Three implications of the model can be examined. First, prior to the transition in old-age survival, saving rates would have been relatively low. Second, constant increases in old-age survival during the transition would have produced relatively constant increases in saving rates. Third, East Asian countries would have experienced relatively elevated saving rates during their period of rapid transition. Of course, these patterns would consistently emerge only if the trends in old-age survival dominated other factors.

First, were the mean saving rates before the old-age transition began? Estimates for five countries are available and presented in Table 2. In all cases, the pre-transition saving rates are low as compared with the saving rates that followed, but the UK saving rate during pre-transition is only slightly less than its transition saving rate and Taiwan's pre-transition saving rate is quite high as compared with the other countries.

Table 2 Mean National Saving Rates in Pre-Transition and Transition Periods. About here.

Second, are the saving rates and old-age survival correlated? The observed saving rates are plotted against the observe survival values in Figure 4 for each of the countries. The US stands out as an exception with a negative simple correlation between saving rates and old-age survival. In the United Kingdom, the positive correlation is modest (0.37). In the other five countries, the correlation between the two variables ranges from 0.64 upward.

The third question is whether rapid changes in survival rates (observed mostly in the countries of East Asia) were associated with higher saving rates. As a simple answer to this question we compare the six countries at three benchmark old-age survival rates – 0.4, 0.5, and 0.6 (Figure 5) – observed for the six countries for which we have values. There is a clear positive association between the national saving rate and the change in the old-age survival rates over the subsequent decade. The simple correlation between the variables ranges from 0.58 to 0.72. The effects are essentially identical for q equal to 0.4 and 0.5 and somewhat attenuated for 0.6. These results provide modest but consistent support for the dynamic model of old-age survival and saving.

4. Analysis of World Panel Data 1965-1995

Estimates of national saving rates, life expectancy at birth, and other variables that may influence saving are available for 76 countries in 1965 increasing to 94 countries in 1995. In this section we present analysis of national saving rates employing these data. The world panel data offers advantages over the historical analysis. First, we can move to a multivariate framework that explicitly incorporates the role of other factors in determining national saving rates. Second, we can explore whether the Western/East Asian distinctions drawn in the historical analysis can be generalized to other countries of the world. There are also disadvantages that are discussed below.

Model Specification

The empirical model incorporates the two effects of old-age survival derived from the OLG model presented in Section 2: the steady-state effect, which interacts with the rate of economic growth, and the transitory effect, which depends on the rate at which old-age survival is increasing. The OLG model implies that both the steady-state effect (β_1) and the transitory effect (β_2) are positive in equation (1):

$$S/Y = \beta_0 + \beta_1 q \cdot Y_{gr} + \beta_2 \Delta q + \beta_4 D1_t \cdot Y_{gr} + \beta_3 Y_{gr} + \beta_5 PRI_t + \varepsilon \qquad (1)$$

where S/Y is national saving rate, q is the old-age survival index, Y_{gr} is the growth rate of GDP, Δq is the change in the old-age survival index during the previous five year period, $D1$ is the youth dependency ratio, and PRI is the relative price of investment goods.

The basic empirical model incorporates three other saving determinants that have been explored in previous studies. The first is the effect of youth dependency. As youth dependency varies over the demographic transition, aggregate saving can be influenced in a variety of ways of which two seem particularly important. First, an increase in the number of children may have a direct effect on current household consumption because of the costs of additional children. The direction of the effect will depend, however, on whether or not a decline in the number of children is associated with a decline in total consumption by children. If the price of children relative to adults is rising and the demand for children is price inelastic, expenditures on children will increase as the number of children declines. In this instance, youth dependency would have a positive effect on saving. If the demand for children is price elastic or if the number of children is changing for reasons unrelated to changes in relative prices, youth dependency will have a negative effect on saving (Mason 1987).

Changes in youth dependency may also influence saving because children provide old-age support either through familial support systems or through public pension and health care systems. To the extent that children are seen as a substitute for pension assets, youth dependency will have a negative effect on saving. The specification of the youth dependency effect follows the variable rate-of-growth (VRG) model (Fry and Mason 1982; Mason 1981, 1987; Kelley and Schmidt 1996).

The second effect included in the basic model is the rate-of-growth effect, that is a feature of the OLG model presented in Section 2 and life-cycle saving models in general (Modigliani and Brumberg 1954). In an economy experiencing more rapid GDP growth, the lifetime earnings of young cohorts are greater relative to the lifetime earnings of older cohorts. To the extent that lifecycle saving is used to shift resources from younger to older ages, saving is concentrated among younger cohorts. Hence, the rate of growth effect is typically positive, but can in principle be negative.[7] The effect of GDP growth is variable, equal to $\beta_1 q + \beta_3 + \beta_4 D1$, because the old-age survival rate and the youth dependency ratio influence the life-cycle profile of consumption. The coefficient β_3 has no economic interpretation in isolation and, hence, may be positive or negative depending on the effects of q and $D1$.

The third determinant included in the basic model is the relative price of investment goods (*PRI*) following Taylor (1995) and Higgins and Williamson (1996, 1997). The *PRI* captures the effect of changing interest rates. An increase in the interest rate will lead to an increase or decrease in saving by prime-age adults and by the

[7] The saving mechanism can be used to shift consumption to younger ages, by accumulating credit card debt, for example, but constraints on indebtedness limit the importance of these transactions.

elderly depending on the relative strengths of the substitution and wealth effects. Thus, the effect of the *PRI* on the national saving rate is an empirical issue.

A potentially important extension of the basic model would allow for transitory youth dependency effects. This possibility can be incorporated into the OLG framework (Higgins 1994 and Williamson and Higgins 2001). A drop in youth dependency will induce prime age adults to save more during their working years in anticipation that they will rely less on familial or public transfers during their retirement years. Current retirees would be unaffected as they are simply dis-saving the (small) assets they accumulated in the expectation that they would be supported by the many children they chose to bear. Hence, aggregate saving would rise steeply. In the next period, however, the higher saving by the new generation of prime age adults would be offset by the higher dis-saving by the new generation of retirees. Hence, saving would decline from the transitory peak to a steady-state peak that would be higher than saving in period *t,* but lower than saving in period *t+1.* Just as is the case for survival, the saving rate will depend on the current level of youth dependency and its rate of change.

Variables, Definitions, the Sample, and Estimation Methods

All variables are taken directly from or constructed using data from the World Development Indicators (WDI 2003). The saving rate (S/Y_t) is the average gross national saving rate for the five-year period *t* to *t+5.* The rate of growth of income is the rate of growth of GDP during the preceding five-year period is the mean of the annual growth rate of GDP in 5 years. The relative price of investment goods (PRI_t) is taken directly from the Penn World Table (PWT) and is the average value for the period *t* to *t+5*. The youth dependency ratio ($D1_t$) is the ratio of the population 0-14 to the population 15-64.

The old-age survival index (*q*) is the ratio of expected person years lived after age 60 (T_{60}) to expected person years lived between ages 30 and 60 ($T_{30}-T_{60}$) given contemporaneous age-specific death rates. T_x, total number of years lived after age *x,* is a standard life table value. Life tables are not available for many countries in many years. Hence, life expectancy at birth from the World Development Indicators (World Bank 200x) were used in conjunction with Coale-Demeny model life tables (Coale and Demeny 1983) to construct estimates of *q.*[8] The change in the old-age survival index is average increase over the preceding five-year period, i.e., $\Delta q_t = q_t - q_{t-5}$.

The full sample consists of 566 observations for 76 countries in 1965 increasing to 94 countries in 1995. Estimates for Western and East Asian countries

[8] See Kinugasa (2004) for additional details.

and for Other Developing Countries are presented separately. Sample means and a list of countries are reported in the appendix.

The equations are estimated by ordinary least squares (OLS) and two stage least squares (2SLS) because the Hausman-Wu test indicates that GDP growth is endogenous. Following Higgins and Williamson (1996, 1997) the rate of growth of the labor force and the lagged values of the national investment rate, the rate of growth of the labor force, the price of investment goods, the price index, real GDP per worker, real GDP per capita, and a measure of openness are used as instruments. All estimates include year and regional dummy variables.

Results

Estimates of the basic model, equation (1), are presented in Table 3. OLS and 2SLS estimates are both presented and they are generally similar. We will limit ourselves to discussion of the 2SLS results. Old-age survival consistently has a large, statistically significant positive effect on national saving rates for the full sample and for the two sub-samples. The change in survival has a statistically significant positive effect on national saving in the West/East Asia (W/EA) sample, but not in the other sub-sample. The youth dependency effect is not statistically significant for the full sample or for the two sub-samples. The effect of *PRI* has a large positive effect in the W/EA and a smaller negative effect elsewhere, but the effects are only marginally significant. The rate of growth effect evaluated at the mean value of q and $D1$ is consistently positive with a value that ranges from 1.4 in W/EA to 0.75 in the non-W/EA sample. An additional result of interest is the substantial East Asian dummy variable coefficient in the W/EA analysis. Rapid increases in adult survival and a high rate of economic growth, both characteristic of East Asia, do not fully explain why saving rates are higher in East Asia than in the West.

The results presented in Table 4 differ from those in Table 3 only in the inclusion of the change in the youth dependency effect – designed to capture the transitory component of its effect on saving. We do not find a significant transitory effect of youth dependency. The inclusion of the change in youth dependency had no important effect on other aspects of the estimates. Old-age survival has a strong positive effect in all estimates; the change in old-age survival has a positive effect in W/EA but not elsewhere. The effects of other variables are similar to those reported in Table 3.

Two aspects of the results warrant emphasis. First, the results imply that the demographic transition has had an important effect on aggregate saving rates. To explore this issue, we have projected saving rates using UN projections of mortality and the youth dependency ratio. Projections for the West and East Asia, holding the youth dependency ratio and all other variables constant, are presented in Figure 6. Projection allowing both the old-age survival ratio and the youth dependency ratio, all other variables held constant, to vary are presented in Figure 7. Values for all projections are provided in Appendix Table 2.

The combined effect of the rise in adult mortality and the decline in youth dependency was to increase the aggregate saving rate by 10.5 percentage points in East Asia, by 4.1 percentage points in the West, and by 10.4 percentage points in the remaining countries based on the 2SLS estimates. Improvements in adult mortality accounted for a little more than three-quarters of the increase in each region while the decline in the youth dependency ratio accounted for a little less than one-quarter of the increase. These results bridge the gap, to some extent, between recent aggregate level analyses that find large demographic effects and the micro-level analysis that find small demographic effects. The combined effects of demographic change are substantial as in the aggregate analysis rates (Kelley and Schmidt 1996; Higgins and Williamson 1997). The age structure effects are of similar magnitude to those found by Deaton and Paxson, while the effects of longevity would be part of the cohort effect in the Deaton and Paxson analysis (Deaton and Paxson 2000).

The second important feature of the results is the implication for population aging and aggregate saving. There is widespread concern, though limited empirical support, that population aging will lead to a decline in aggregate saving rates. The empirical results presented do not support that conclusion. If old-age survival rates continue to increase, as is widely expected, our empirical results imply that saving rates will continue to rise. This empirical finding is consistent with the Lee, Mason and Miller simulations and suggests that economic growth may not slow as much with population aging as is anticipated in some quarters.

5. RESERVATIONS

An important unanswered question in this analysis is why no dynamic effect of old-age survival is found in the non-W/EA sample. One possibility is that drawbacks with the world panel data are responsible. The first limitation of the data is its relatively short time frame. For most economic analysis thirty years of data are more than adequate, but thirty years is only the length of a single generation. In a sense, we have a single observation of the OLG model presented in Section 2. The prime age adults/workers of 1965 are the old-age population in 1995.

A second difficulty, discussed in Section 3, is that the 1965-95 period may not be well-suited to testing our theoretical saving model. The countries of the West enjoyed similar and relatively constant increases in old-age survival; hence, analyzing variation across countries or across time is unlikely to shed much light on the role of increases in old-age survival. The Asian experience may be more fertile ground to analyze as suggested in Section 3. What about the rest of the developing world? Until the mid-1980s the gains in life expectancy were relative constant across the world. That the simple correlation between life expectancy at birth for the first half of the 1960s and the second half of the 1960s was 0.997 for the 176 countries for which the UN reports estimates illustrates the point.

Two groups of countries experienced significant departures from their historical trends beginning in the mid-1980s primarily because of two important events – the break-up of the Soviet empire and the emergence of the HIV/AIDS epidemic in sub-Saharan Africa. Regional conflicts also played a role in the Middle East and Africa. If the saving model is applicable to these mortality crises, saving rates should have declined.

A third and related issue is that the measures of mortality in the international panel data are not ideal. We rely on model life tables to transform life expectancy at birth into the old-age survival ratio described in the previous section. Whether this is appropriate in all circumstances and, in particular, is reliable under severe mortality crises is a question to which we do not have a satisfactory answer. Moreover, the measure of the speed of mortality decline is for five-year periods. It may be that expectations about increases in old-age survival evolve much more slowly. Perhaps even generation length changes in old-age survival – a measure more consistent with our theoretical model – would be more appropriate.

It is not our intention to suggest that absence of a dynamic effect in the non-W/EA sample must surely be the fault of the data rather than the model. Higher saving rates are not the only possible response to an increase in the number of years lived at old age. One possibility is that consumption at old age may decline. Another is that the elderly may choose to increase their labor force participation (although the opposite is the case as an empirical matter). Still another response is that transfer systems, either public or familial, can be expanded to meet the needs of a growing elderly population. Further work on these topics is clearly needed.

6. CONCLUSIONS

This is not the first paper to conclude that the increased duration of life could lead to higher saving rates. At the individual or household level, it is obvious that higher saving rates are a likely response to an increased duration of retirement. The effect on aggregate saving is more complex, however, because there are both behavioral responses and age composition effects at play. An important contribution of this paper is to show that the aggregate saving rate depends on both the level and the rate at which old-age survival is increasing.

The empirical results provide strong and consistent evidence that an increase in the portion of adult life lived at old ages leads to an increase in saving rates. This finding holds for all samples and specifications. The evidence for the dynamic effect, i.e., the effect of the rate of change in old-age survival, is more fragile. When analysis is confined to the West/East Asia sample we find a statistically significant effect. Moreover, the long-run historical patterns available for countries from East Asia and the West are consistent with the dynamic effect. In other parts of the contemporary developing world, however, we do not find any support for a dynamic effect.

There are two important implications of the empirical analysis. The first is that the demographic transition had a strong positive effect on aggregate saving rates, but that most of the effect can be traced to changes in old-age survival rather than changes in youth dependency. This finding may help to reconcile the divergent findings of studies based on the analysis of aggregate data and household survey data. The second important implication is that population aging will not lead to a decline in saving rates. Any compositional effects associated with population aging are outweighed by the behavioral effects of increased longevity on saving.

Appendix 1 National Saving Rate in a Closed Economy

A greater survival rate brings capital deepening ($\partial k^* / \partial q^* > 0$). If GDP growth rate is greater than the deprecation rate, the saving rate increases. If GDP is growing at a rate less than the rate of depreciation, an increase in q^* has a negative effect on the saving rate.

The effect of the national saving rate of a one-time, anticipated increase of the survival rate is $\frac{\partial (S_t / Y_t)}{\partial q_t} = \frac{gn}{k^{*\phi}} \frac{dk_{t+1}}{dq_t} > 0$. An anticipated increase in the survival rate at time t leads to a higher national saving rate. At time t, saving of prime-age adults increases, which causes an increase in k_{t+1}. The supply of capital increases and the saving rate increases. The effect of an increase in the survival rate at time t on the national saving rate at time t+1

is: $\frac{\partial (S_{t+1}/Y_{t+1})}{\partial q_t} = k_{t+1}^{-\phi} \left[gn\left(\frac{\partial k_{t+2}}{\partial k_{t+1}} - \frac{k_{t+2}}{k_{t+1}}\phi \right) - (1-\phi)(1-\xi) \right] \frac{\partial k_{t+1}}{\partial q_t}$,

where $0 < \partial k_{t+2} / \partial k_{t+1} < 1$ and $\partial k_{t+1} / \partial q_t > 0$ hold. For plausible parameter values, this expression is negative. The saving at time $t+1$ is the difference between the wealth at time t+2 and t+1. An increase in q_t induces capital deepening at time t+1, but the wealth of the previous period and depreciation are also higher than at time t. The net increase in wealth at time t+1 is less than that at time t. In a closed economy, the survival rate at time t also influences the saving rate at time $t+2$. This stands in contrast to the case of small open economy. The survival rate at time t has a negative effect on the saving rate after time t+2.[9]

[9] $\frac{\partial (S_{t+2}/Y_{t+2})}{\partial q_t} = k_{t+2}^{-\phi} \left[gn\left(\frac{\partial k_{t+3}}{\partial k_{t+2}} - \frac{k_{t+3}}{k_{t+2}}\phi \right) - (1-\phi)(1-\xi) \right] \frac{\partial k_{t+2}}{\partial k_{t+1}} \frac{\partial k_{t+1}}{\partial q_t}$, $0 < \partial k_{t+3} / \partial k_{t+2} < 1$, $0 < \partial k_{t+2} / \partial k_{t+1} < 1$, and $\partial k_{t+1} / \partial q_t > 0$ hold, therefore, in the right hand side of this equation, the value inside the bracket is negative for plausible parameters, so that the saving rate at time t has a negative effect on the saving rate at time $t+2$. In the same way, the effects of the survival rate at time t on the saving rate after time $t+2$ can be derived. q_t has a negative effect on the saving rate after time $t+2$.

Appendix 2 List of Countries

Western countries contain Austria, Azerbaijan, Belgium, Bulgaria, Belarus, Canada, Switzerland, Czech Republic, Denmark, Spain, Finland, France, United Kingdom, Greece, Hungary, Ireland, Iceland, Italy, Kazakhstan, Kyrgyz Republic, Lithuania, Luxembourg, Latvia, Moldova, Macedonia, Netherlands, Norway, New Zealand, Poland, Portugal, Romania, Slovak Republic, Slovenia, Sweden, Tajikistan, Turkey, Ukraine, and United States. East Asian countries contain Japan, South Korea, Thailand and Malaysia.

Other countries contain Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Cote d'Ivoire, Cameroon, Congo Republic, Comoros, Cape Verde, Ethiopia, Gabon, Ghana, Guinea, Gambia, Guinea Bissau, Equatorial Guinea, Kenya, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Seychelles, Chad, Togo, Tanzania, Uganda, South Africa, Democratic Republic of the Congo, Zambia and Zimbabwe, Bangladesh, China, Hong Kong, Indonesia, India, Sri Lanka, Macao, Nepal, Pakistan, Philippines, Argentina, Antigua and Barbuda, Belize, Bolivia, Brazil, Barbados, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, Guyana, Honduras, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Trinidad and Tobago, Uruguay, St. Vincent and the Grenadine, Venezuela, Algeria, Egypt, Iran, Israel, Jordan, Lebanon, Morocco, Syrian Arab Republic, Tunisia, and Yemen.

References

Bloom, D. E., D. Canning, et al. (2003). "Longevity and Life-cycle Savings." Scandinavian Journal of Economics **105**(3): 319-338.

Borsch-Supan, A. (1996). The Impact of Population Ageing on Savings, Investment and Growth in the OECD Area. Future global capital shortages: Real threat or pure fiction? Organisation-for-Economic-Co-operation and-Development. Paris, Author**:** 103-41.

Cutler, D. M., J. M. Poterba, et al. (1990). "An Aging Society: Opportunity or Challenge?" Brookings Papers on Economic Activity(1): 1-56.

Davies, J. B. (1981). "Uncertain Lifetime, Consumption, and Dissaving in Retirement." Journal of Political Economy **89**(3): 561-577.

Deaton, A. and C. H. Paxson (2000). Growth, Demographic Structure, and National Saving in Taiwan. Population and Economic Change in East Asia, A Supplement to Population and Development Review. R. Lee and C. Y. C. Chu. New York, Population Council. **26:** 141-173.

Higgins, M. (1994). The demographic determinants of savings, investment and international capital flows. Department of Economics. Cambridge, MA, Harvard University.

Higgins, M. and J. G. Williamson (1997). "Age Structure Dynamics in Asia and Dependence on Foreign Capital." Population and Development Review **23**(2): 261-93.

Kageyama, J. (2003). "The Effects of a Continuous Increase in Lifetime on Saving." Review of Income and Wealth **49**(2): 163-183.

Kelley, A. C. and R. M. Schmidt (1996). "Saving, Dependency and Development." Journal of Population Economics **9**(4): 365-86.

Kinugasa, T. (2004). Life Expectancy, Labor Force, and Saving, Ph.D. Dissertation. University of Hawaii at Manoa.

Kuehlwein, M. (1993). "Life-Cycle and Altruistic Theories of Saving with Lifetime Uncertainty." Review of Economics and Statistics **75**(1): 38-47.

Lee, R., A. Mason, et al. (2000). "Life Cycle Saving and the Demographic Transition in East Asia." Population and Development Review **26**(Supplement).

Lee, R. D., A. Mason, et al. (2001a). Saving, Wealth, and Population. Population Does Matter: Demography, Poverty, and Economic Growth. N. Birdsall, A. C. Kelley and S. W. Sinding. Oxford, Oxford University Press**:** 137-164.

Lee, R. D., A. Mason, et al. (2001b). Saving, Wealth, and the Demographic Transition in East Asia. Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized. A. Mason. Stanford, Stanford University Press**:** 155-184.

Leung, S. F. (1994). "Uncertain Lifetime, the Theory of the Consumer, and the Life Cycle Hypothesis." Econometrica **62**(5): 1233-39.

Mason, A. (1981). "An Extension of the Life-Cycle Model and Its Application to Population Growth and Aggregate Saving." East-West Population Institute Working Papers, Honolulu: East-West Center **4**.

Mason, A. (1987). National Saving Rates and Population Growth: A New Model and New Evidence. Population growth and economic development: Issues and evidence. D. G. Johnson and R. D. Lee. Social Demography series, Madison, Wis., University of Wisconsin Press**:** 523-60.

Mason, A. (1988). "Saving, Economic Growth, and Demographic Change." Population and Development Review **14**(1): 113-44.

Bloom, D. E., D. Canning, et al. (2003). "Longevity and Life-cycle Savings." Scandinavian Journal of Economics **105**(3): 319-338.

Borsch-Supan, A. (1996). The Impact of Population Ageing on Savings, Investment and Growth in the OECD Area. Future global capital shortages: Real threat or pure fiction? Organisation-for-Economic-Co-operation and-Development. Paris, Author**:** 103-41.

Cutler, D. M., J. M. Poterba, et al. (1990). "An Aging Society: Opportunity or Challenge?" Brookings Papers on Economic Activity(1): 1-56.

Davies, J. B. (1981). "Uncertain Lifetime, Consumption, and Dissaving in Retirement." Journal of Political Economy **89**(3): 561-577.

Deaton, A. and C. H. Paxson (2000). Growth, Demographic Structure, and National Saving in Taiwan. Population and Economic Change in East Asia, A Supplement to Population and Development Review. R. Lee and C. Y. C. Chu. New York, Population Council. **26:** 141-173.

Higgins, M. (1994). The demographic determinants of savings, investment and international capital flows. Department of Economics. Cambridge, MA, Harvard University.

Higgins, M. and J. G. Williamson (1997). "Age Structure Dynamics in Asia and Dependence on Foreign Capital." Population and Development Review **23**(2): 261-93.

Kageyama, J. (2003). "The Effects of a Continuous Increase in Lifetime on Saving." Review of Income and Wealth **49**(2): 163-183.

Kelley, A. C. and R. M. Schmidt (1996). "Saving, Dependency and Development." Journal of Population Economics **9**(4): 365-86.

Kinugasa, T. (2004). Life Expectancy, Labor Force, and Saving, Ph.D. Dissertation. University of Hawaii at Manoa.

Kuehlwein, M. (1993). "Life-Cycle and Altruistic Theories of Saving with Lifetime Uncertainty." Review of Economics and Statistics **75**(1): 38-47.

Lee, R., A. Mason, et al. (2000). "Life Cycle Saving and the Demographic Transition in East Asia." Population and Development Review **26**(Supplement).

Lee, R. D., A. Mason, et al. (2001a). Saving, Wealth, and Population. Population Does Matter: Demography, Poverty, and Economic Growth. N. Birdsall, A. C. Kelley and S. W. Sinding. Oxford, Oxford University Press: 137-164.

Lee, R. D., A. Mason, et al. (2001b). Saving, Wealth, and the Demographic Transition in East Asia. Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized. A. Mason. Stanford, Stanford University Press: 155-184.

Leung, S. F. (1994). "Uncertain Lifetime, the Theory of the Consumer, and the Life Cycle Hypothesis." Econometrica **62**(5): 1233-39.

Mason, A. (1981). "An Extension of the Life-Cycle Model and Its Application to Population Growth and Aggregate Saving." East-West Population Institute Working Papers, Honolulu: East-West Center **4**.

Mason, A. (1987). National Saving Rates and Population Growth: A New Model and New Evidence. Population growth and economic development: Issues and evidence. D. G. Johnson and R. D. Lee. Social Demography series, Madison, Wis., University of Wisconsin Press: 523-60.

Mason, A. (1988). "Saving, Economic Growth, and Demographic Change." Population and Development Review **14**(1): 113-44.

Modigliani, F. and R. Brumberg (1954). Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data. Post-Keynesian Economics. K. K. Kurihara. New Brunswick, N.J., Rutgers University Press.

Schieber, S. J. and J. B. Shoven (1996). Population Aging and Saving for Retirement. The mosaic of economic growth. -. R. Landau, -. T. Taylor and -. G. Wright, eds,. Stanford, Stanford University Press: 150-72.

Williamson, J. G. and M. Higgins (2001). The Accumulation and Demography Connection in East Asia. Population Change and Economic Development in

East Asia: Challenges Met, Opportunitites Seized. A. Mason. Stanford, Stanford University Press**:** 123-54.

Yaari, M. E. (1965). "Uncertain Lifetime, LIfe Insurance, and the Theory of the Consumer." The Review of Economics Studies **32**(2): 137-150.

Zilcha, I. and J. Friedman (1985). "Saving Behavior in Retirement when Life Horizon in Uncertain." Economic Letters **17**(1-2): 63-66.

Schieber, S. J. and J. B. Shoven (1996). Population Aging and Saving for Retirement. The mosaic of economic growth. -. R. Landau, -. T. Taylor and -. G. Wright, eds,. Stanford, Stanford University Press**:** 150-72.

Williamson, J. G. and M. Higgins (2001). The Accumulation and Demography Connection in East Asia. Population Change and Economic Development in East Asia: Challenges Met, Opportunitites Seized. A. Mason. Stanford, Stanford University Press**:** 123-54.

World Bank (2003). World Development Indicators 2003, Washington, D.C.

Yaari, M. E. (1965). "Uncertain Lifetime, LIfe Insurance, and the Theory of the Consumer." The Review of Economics Studies **32**(2): 137-150.

Zilcha, I. and J. Friedman (1985). "Saving Behavior in Retirement when Life Horizon in Uncertain." Economic Letters **17**(1-2): 63-66.

Figure 1 Demand and Supply of Capital in a Closed Economy

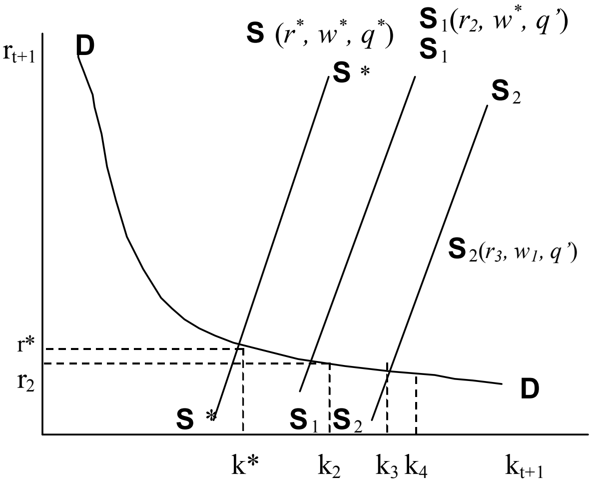


Figure 2 The Effect of an Increase in the Survival Rate at Time *t*

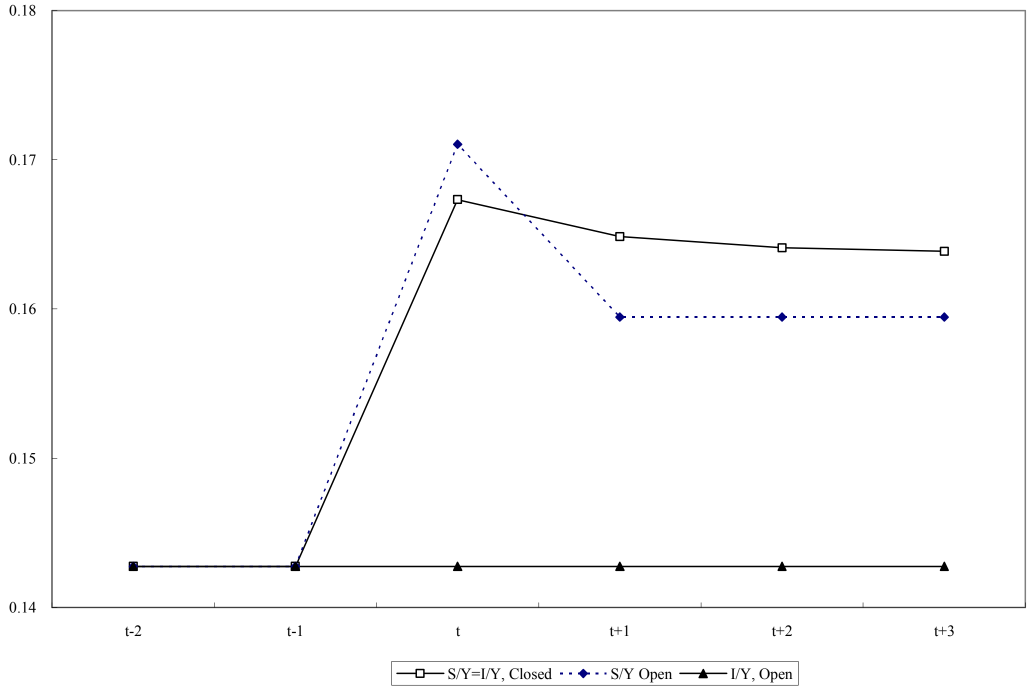


Figure 3 The Effect of a Continuing Increase in the Survival Rate

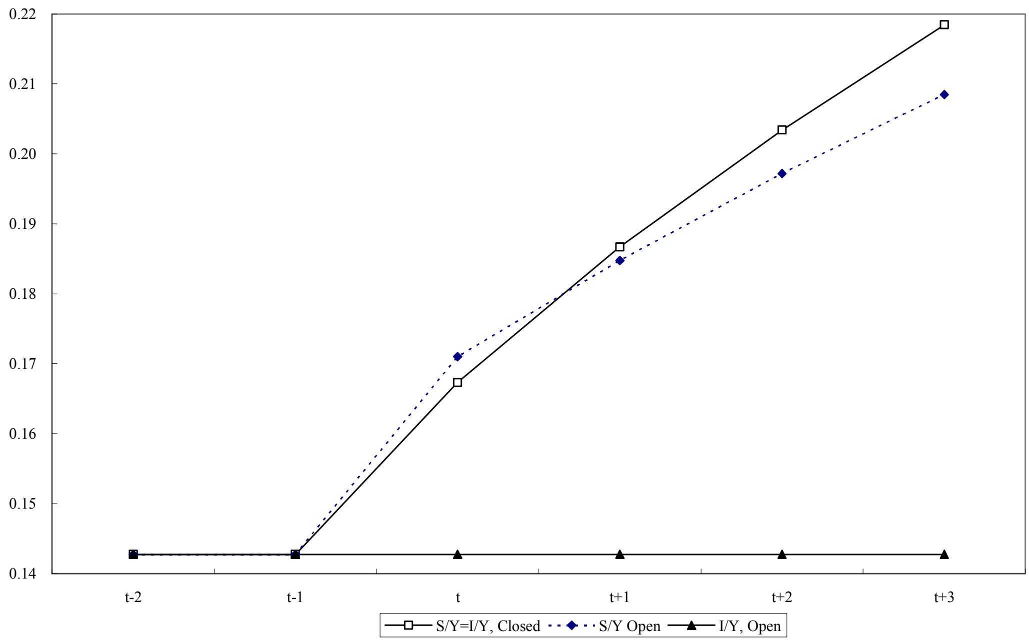


Figure 4 Adult Survival Index and the National Saving Rate

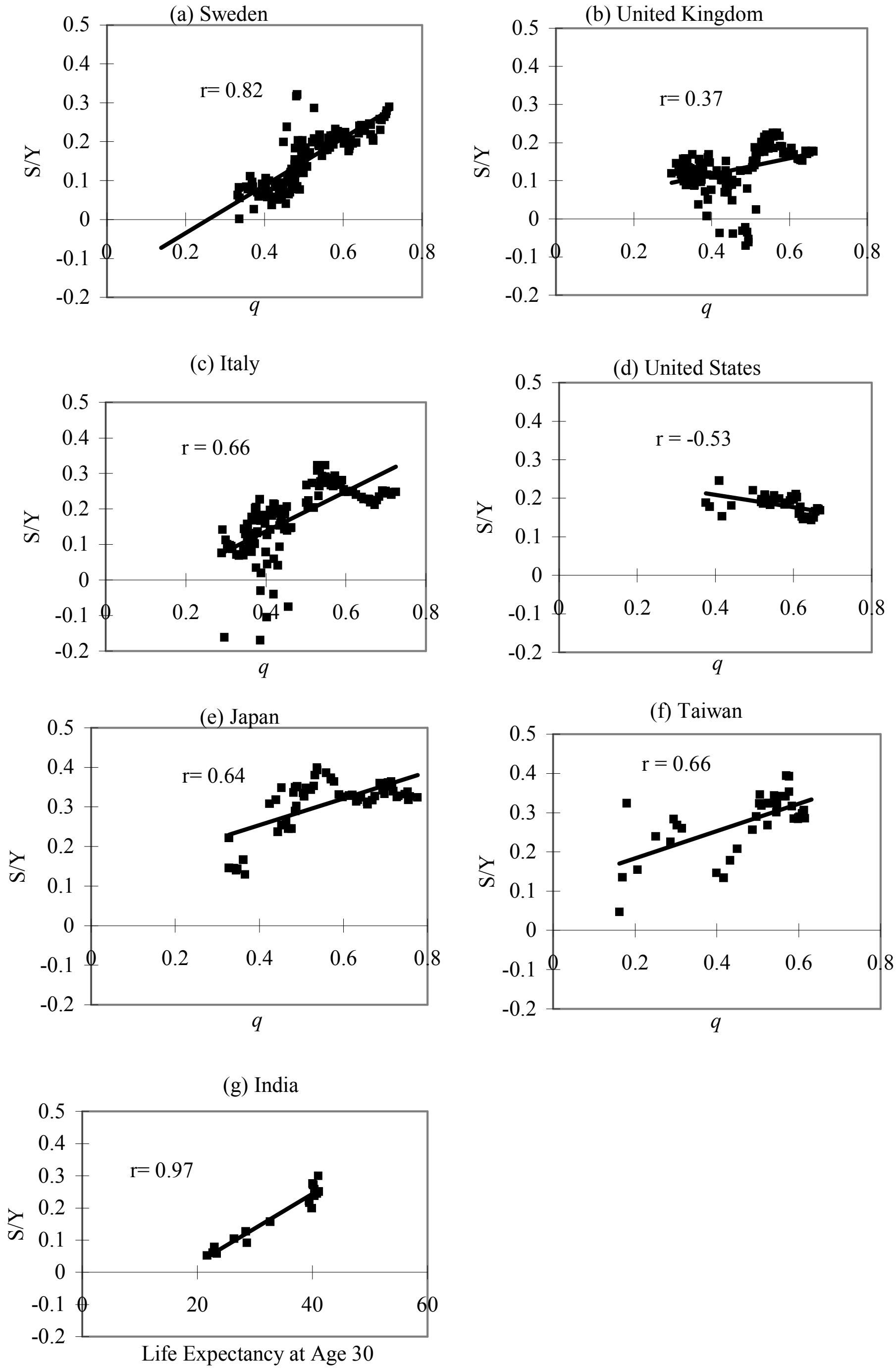


Figure 5 Changes in Old-Age Survival Index and the National Saving Rate

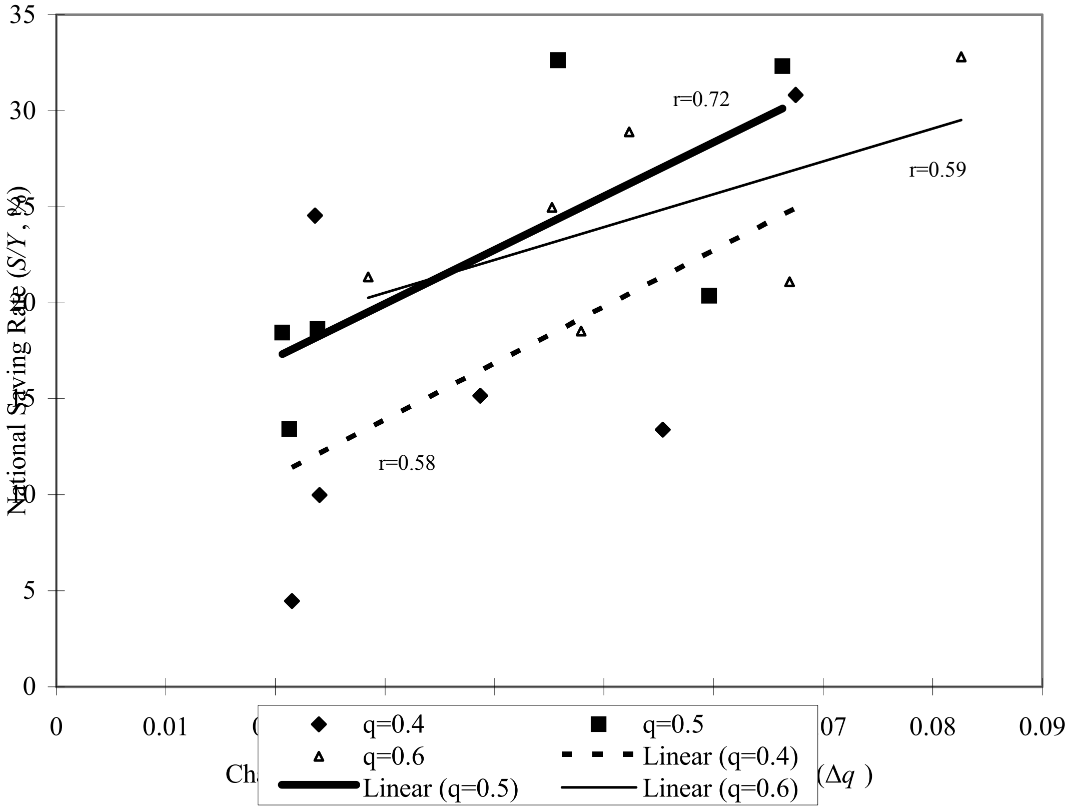
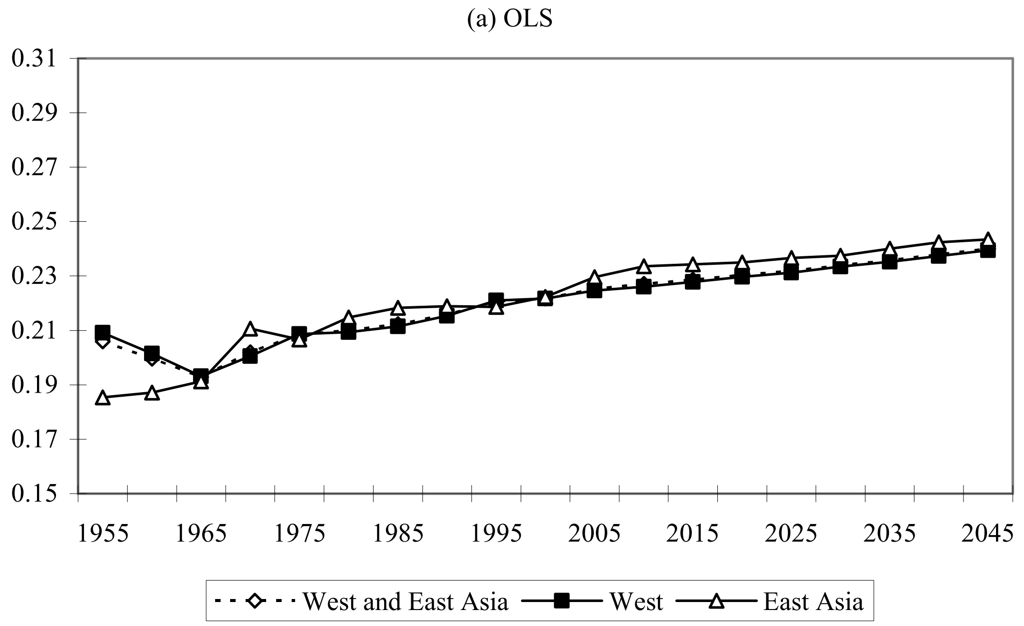


Figure 6 Projected Saving Rates of Western Countries and East Asia (Constant Youth Dependency, 1955-2050)



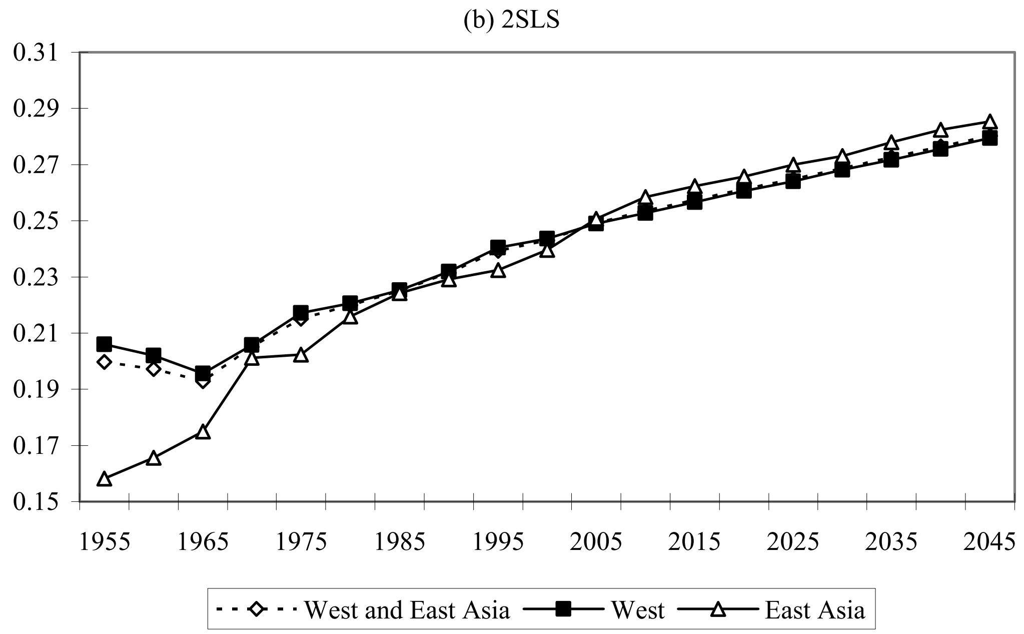
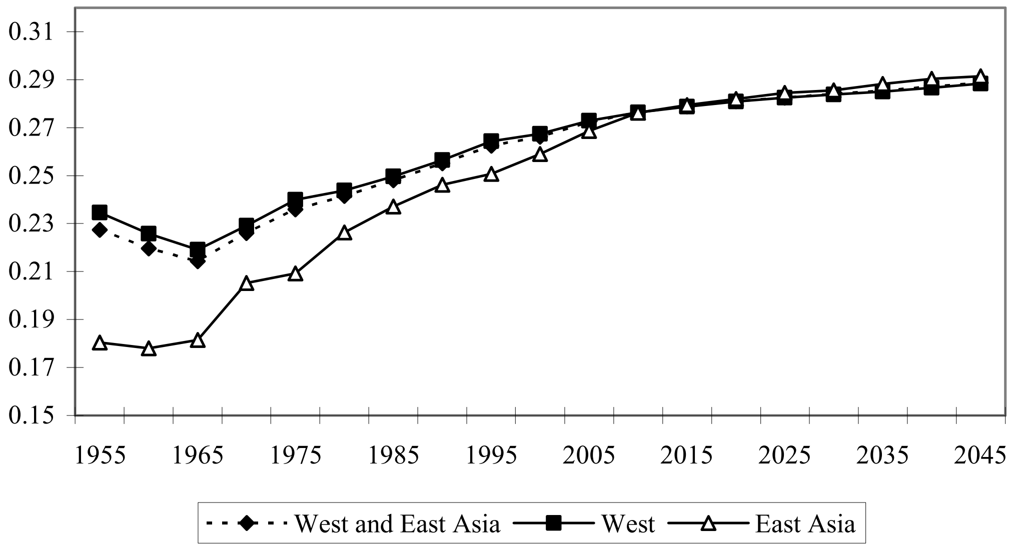


Figure 7 Projected Saving Rates of Western Countries and East Asia (Changing Youth Dependency, 1955-2050)

(a) OLS



(b) 2SLS

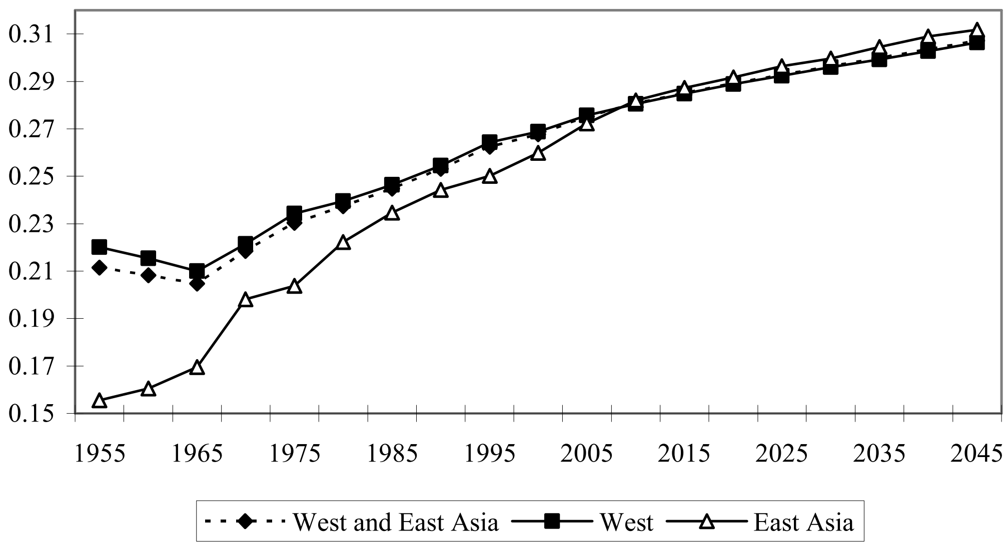


Table 1. Structural Changes of the Old-Age Survival Index

	Sweden	United Kingdom	Italy	United States	Japan	Taiwan	India
years	1751-2002	1841-1998	1872-2000	1900-2001	1891-2001	1906-2002	1881-1997
t_1	1876	1900			1947	1940	1951
t_2					1989	1983	1989
t	0.0006 ***	0.0009 ***	0.0029 ***	0.0033 ***	0.0010 ***	0.0004	0.0392
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0010)	(0.0232)
$(t-t_1)d_1$	0.002 ***	0.0024 ***			0.0065 ***	0.0056 ***	0.3457 ***
	(0.0001)	(0.0001)			(0.0004)	(0.0011)	(0.0599)
$(t-t_2)d_2$					-0.0014 ***	-0.0024 ***	-0.3075 *
					(0.0007)	(0.0003)	(0.1568)
Dm1773	-0.0231 ***	0.0004 ***	-0.1231 ***				
	(0.0027)		(0.0023)				
Dm1808	-0.1625 ***						
	(0.0063)						
Dm1918	-0.096 ***						
	(0.0040)						
Constant	0.2869 ***	0.3205 ***	0.2518 ***	0.2245 ***	0.3250 ***	0.2860 ***	22.7955 ***
	(0.0080)	(0.0049)	(0.0053)	(0.0195)	(0.0104)	(0.0322)	(0.8454)
Adjusted R^2	0.9251	0.9587	0.9471	0.9585	0.9872	0.9944	0.9628
N	252	158	129	48	59	43	20
P-value	0.0000	0.0000			0.0000	0.0000	0.0000
D.W.	0.5765	0.7026	0.397	0.0958	0.3897	0.3651	0.0338

(Note) Dependent variables are adult survival index except India. The dependent variable for India is life expectancy at age 30. The equation $q_t = \beta_0 + \beta_1 t + \beta_2 d_1 (t - t_1) + \beta_3 d_2 (t - t_2) + \varepsilon_t$ is estimated, where $d_1 = 1$ if $t \geq t_1$ and 0 otherwise, and d_2=1 if $t \geq t_2$ and 0 otherwise. Dm1773 is dummy variable of year 1773=1. In the same way, Dm1808, Dm1918 are defined. *N* is number of observations. "P-value" is the p-value of F-test for the null hypothesis that β_1, β_2, and β_3 are all zero. D.W. is Durbin-Watson statistics. The low Durbin-Watson statistics imply serial correlation. The Augmented Dickey-Fuller test indicates that some variables are not trend stationary. These issues will be explored further.

Table 2 Mean National Saving Rates in Pre-Transition and Transition Periods.

	Sweden	United Kingdom	Italy	United States	Japan	Taiwan	India[a)]
Pre-transition	1751-1875	1841-1899	<1872	<1900	1891-1947	1906-1939	1900-1950
Survival rate	0.31	0.34	na	na	0.35	0.24	24.0
Saving rate	7.3	11.6	na	na	15.7	22.1	6.9
Transition	1876-2000	1900-1998	1872-2000	1900-2001	1947-2000	1940-1999	1951-1997
Survival rate	0.53	0.49	0.47	0.57	0.60	0.54	37.7
Saving rate	16.6	13	17.7	17.7	32.6	26.1	17.7

(Note) Life expectancy at age 30 is presented instead of survival rate in India.

Table 3 Estimated Saving Equation with Old-Age Survival Index and Youth Dependency

	(1) Whole World		(2) West and East Asia		(3) Non-West, Non East Asia	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
$q*Y_{gr}$	8.2055 ***	14.8399 ***	8.3714 **	14.8129 ***	9.1327 ***	15.7251 ***
	(1.8606)	(2.6660)	(3.7148)	(3.5266)	(1.9979)	(2.9857)
dq	0.8615	0.5104	1.7954 **	1.8115 **	0.3284	-0.2538
	(0.5266)	(0.5752)	(0.8192)	(0.8519)	(0.5962)	(0.6823)
$D1*Y_{gr}$	0.7461	0.9319	-3.0912 ***	-1.7057	0.4379	1.0155
	(0.7639)	(0.9345)	(1.1164)	(1.1246)	(0.9871)	(1.2978)
Y_{gr}	-3.7274 ***	-6.5927 ***	-2.9073	-6.4693 ***	-3.6892 **	-6.8701 ***
	(1.3526)	(1.9655)	(2.4628)	(2.3958)	(1.5577)	(2.4026)
PRI	-0.0053 *	-0.0028	0.0422 **	0.0350 *	-0.0084 **	-0.0064 *
	(0.0032)	(0.0036)	(0.0207)	(0.0212)	(0.0035)	(0.0036)
y70	0.0100	0.0075	0.0093	0.0105	0.0069	0.0026
	(0.0181)	(0.0184)	(0.0161)	(0.0159)	(0.0251)	(0.0253)
y75	-0.0175	-0.0253	-0.0280 *	-0.0250	-0.0261	-0.0373
	(0.0166)	(0.0176)	(0.0159)	(0.0159)	(0.0233)	(0.0241)
y80	-0.0253	-0.0290	-0.0280	-0.0167	-0.0433 *	-0.0543 **
	(0.0165)	(0.0188)	(0.0198)	(0.0238)	(0.0222)	(0.0234)
y85	-0.0031	-0.0013	0.0001	0.0184	-0.0272	-0.0345
	(0.0163)	(0.0218)	(0.0173)	(0.0207)	(0.0226)	(0.0272)
y90	-0.0102	-0.0185	-0.0340 *	-0.0255	-0.0258	-0.0398
	(0.0161)	(0.0197)	(0.0175)	(0.0191)	(0.0225)	(0.0257)
y95	-0.0009	-0.0086	-0.0039	0.0196	-0.0339	-0.0598 **
	(0.0168)	(0.0235)	(0.0197)	(0.0231)	(0.0235)	(0.0285)
East Asia	0.0312 **	0.0189	0.1073 ***	0.0855 ***		
	(0.0137)	(0.0175)	(0.0165)	(0.0202)		
Other	-0.1190 ***	-0.0915 ***				
Countries	(0.0093)	(0.0125)				
Constant	0.1775 ***	0.1487 ***	0.1544 ***	0.1267 ***	0.0758 ***	0.0855 ***
	(0.0161)	(0.0245)	(0.0247)	(0.0306)	(0.0205)	(0.0305)
N	566	566	189	189	377	377
Adjusted R	0.4357	0.3945	0.4191	0.3848	0.1275	0.0852
P-values, Yg	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pvalues, year	0.2800	0.1160	0.0125	0.0006	0.2261	0.0954
Y_{gr} Effect	0.7203	1.1739	0.6967	1.4105	0.6177	0.7543
P-value, Hausman		0.0000		0.0037		0.0000

Note: The dependent variable is the national saving rate.

q: Adult survival index, Y_{gr}: GDP growth rate, $D1$: young dependency rate, Δq: change in the adult survival rate, *PRI*: price of investment goods, yXX dummy variables of year XX, N: number of observation. "P-value, *Ygr* " is the p-value of F-test of the null hypothesis that the both coefficients of $q{\cdot}Y_{gr}$ and $D1{\cdot}Y_{gr}$ are zero. "Pvalue, year dummies" is the p-value of F-test of the null hypothesis that all the year dummies are zero. " Y_{gr} Effect" is the partial effect of an increase in GDP growth.

*** denotes significant at 1 % level, **denotes significant at 5 % level, and * denotes significant at 10 % level. Figures in parentheses are standard errors.

Table 4 Estimated Saving Equation with Old-Age Survival Index, Youth Dependency Ratio, and Change in Youth Dependency Ratio.

	(1) Whole World		(2) West and East Asia		(3) Non-West, Non East Asia	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
$q*Y_{gr}$	7.7208 ***	15.0384 ***	8.3557 **	14.9335 ***	8.5464 ***	15.5319 ***
	(1.9440)	(2.6829)	(3.7186)	(3.5232)	(2.1327)	(3.0590)
dq	0.7583	0.5583	1.7700 **	1.8046 **	0.1871	-0.2512
	(0.5219)	(0.5917)	(0.8029)	(0.8247)	(0.5895)	(0.6847)
$D1*Y_{gr}$	0.7615	0.8210	-3.0871 ***	-1.6881	0.7026	0.9864
	(0.7684)	(0.9166)	(1.1214)	(1.1255)	(1.0056)	(1.3233)
$dD1$	-0.1753	0.0543	-0.0373	-0.0186	-0.2402	-0.0387
	(0.1417)	(0.1475)	(0.1696)	(0.1787)	(0.1757)	(0.1820)
Y_{gr}	-3.5424 ***	-6.6263 ***	-2.9015	-6.5589 ***	-3.6873 **	-6.8041 ***
	(1.3817)	(1.9559)	(2.4665)	(2.3938)	(1.6018)	(2.4076)
PRI	-0.0049	-0.0029	0.0426 **	0.0346 *	-0.0078 **	-0.0064 *
	(0.0033)	(0.0036)	(0.0207)	(0.0210)	(0.0036)	(0.0036)
y70	0.0066	0.0084	0.0090	0.0103	0.0010	0.0016
	(0.0183)	(0.0186)	(0.0164)	(0.0161)	(0.0257)	(0.0257)
y75	-0.0234	-0.0238	-0.0289 *	-0.0255	-0.0353	-0.0389
	(0.0167)	(0.0180)	(0.0173)	(0.0177)	(0.0236)	(0.0248)
y80	-0.0331 **	-0.0272	-0.0292	-0.0176	-0.0546 ***	-0.0564 **
	(0.0169)	(0.0195)	(0.0222)	(0.0267)	(0.0229)	(0.0241)
y85	-0.0105	-0.0001	-0.0012	0.0172	-0.0372 *	-0.0370
	(0.0168)	(0.0226)	(0.0196)	(0.0243)	(0.0232)	(0.0281)
y90	-0.0175	-0.0174	-0.0349 *	-0.0264	-0.0376 *	-0.0423
	(0.0164)	(0.0202)	(0.0186)	(0.0209)	(0.0235)	(0.0268)
y95	-0.0097	-0.0072	-0.0046	0.0186	-0.0476 *	-0.0627 **
	(0.0171)	(0.0237)	(0.0205)	(0.0250)	(0.0244)	(0.0290)
East Asia	0.0285 **	0.0207	0.1065 ***	0.0856 ***	0.0035	
	(0.0141)	(0.0176)	(0.0163)	(0.0194)	(0.0136)	
Other	-0.1192 ***	-0.0896 ***				
Countries	(0.0094)	(0.0125)				
Constant	0.1836 ***	0.1471 ***	0.1544 ***	0.1279 ***	0.0850 ***	0.0886 ***
	(0.0162)	(0.0246)	(0.0249)	(0.0311)	(0.0214)	(0.0309)
N	566	566	189	189	377	377
Adjusted R^2	0.4373	0.3897	0.4160	0.3822	0.1298	0.0856
P-values, Ygr	0.0001	0.0000	0.0000	0.0000	0.0002	0.0000
Pvalues, year dummies	0.1703	0.1466	0.0144	0.0007	0.0873	0.0815
Y_{gr} Effect	0.6821	1.1621	0.6951	1.3976	0.5767	0.7133
P-value, Hausman		0.0000		0.0033		0.0000

Appendix Table 1 Summary of the Variables

Variable	Total N	Total Mean	Total Standard Deviation	1965 N	1965 Mean	1965 Standard Deviation	1970 N	1970 Mean	1970 Standard Deviation
S/Y	566	0.1279	0.1211	76	0.1355	0.1369	76	0.1462	0.1300
Y_{gr}	566	0.0387	0.0318	76	0.0548	0.0315	76	0.0510	0.0240
q	566	0.4816	0.1004	76	0.4380	0.0977	76	0.4503	0.0960
dq	566	0.0126	0.0097	76	0.0140	0.0066	76	0.0134	0.0068
$D1$	566	0.6646	0.2374	76	0.7230	0.2137	76	0.7202	0.2170
$dD1$	566	-0.0151	0.0417	76	0.0191	0.0370	76	-0.0003	0.0336
PRI	566	0.8473	0.7492	76	0.7143	0.6090	76	0.8310	0.8267
D	566	0.4938	0.5182	76	0.2667	0.3829	76	0.3185	0.4234
dD	566	0.0678	0.0778	76	0.0197	0.0511	76	0.0518	0.0774

Variable	1975 N	1975 Mean	1975 Standard Deviation	1980 N	1980 Mean	1980 Standard Deviation	1985 N	1985 Mean	1985 Standard Deviation
S/Y	76	0.1261	0.1114	78	0.1140	0.1152	81	0.1241	0.1168
Y_{gr}	76	0.0481	0.0270	78	0.0418	0.0344	81	0.0252	0.0319
q	76	0.4686	0.0955	78	0.4846	0.0960	81	0.4959	0.0961
dq	76	0.0147	0.0072	78	0.0149	0.0081	81	0.0143	0.0069
$D1$	76	0.6963	0.2258	78	0.6644	0.2326	81	0.6466	0.2440
$dD1$	76	-0.0173	0.0406	78	-0.0267	0.0453	81	-0.0221	0.0427
PRI	76	1.0199	1.3963	78	0.8903	0.7807	81	0.7923	0.3353
D	76	0.4139	0.4803	78	0.5010	0.5106	81	0.5596	0.5406
dD	76	0.0823	0.0930	78	0.0783	0.0750	81	0.0772	0.0716

Variable	1990 N	1990 Mean	1990 Standard Deviation	1995 N	1995 Mean	1995 Standard Deviation
S/Y	85	0.1256	0.1142	94	0.1257	0.1235
Y_{gr}	85	0.0335	0.0219	94	0.0219	0.0332
q	85	0.5104	0.0949	94	0.5119	0.1034
dq	85	0.0119	0.0108	94	0.0067	0.0144
$D1$	85	0.6232	0.2486	94	0.5996	0.2500
$dD1$	85	-0.0245	0.0307	94	-0.0287	0.0392
PRI	85	0.8623	0.4620	94	0.8264	0.3861
D	85	0.6337	0.5393	94	0.6946	0.5638
dD	85	0.0759	0.0776	94	0.0835	0.0750

Variable	Western and East Asian Countries N	Mean	Standard Deviation	Other Countries N	Mean	Standard Deviation
S/Y	189	0.2295	0.0711	377	0.0770	0.1082
Y_{gr}	189	0.0395	0.0280	377	0.0383	0.0335
q	189	0.5779	0.0487	377	0.4333	0.0834
dq	189	0.0122	0.0075	377	0.0128	0.0106
$D1$	189	0.3992	0.1405	377	0.7976	0.1473
$dD1$	189	-0.0253	0.0305	377	-0.0099	0.0455
PRI	189	0.7983	0.2404	377	0.8718	0.9015
D	189	1.0653	0.3641	377	0.2073	0.3013
dD	189	0.0975	0.0802	377	0.0528	0.0722

Appendix Table 2 Adult Survival Index and Projected National Saving Rate

(1) West and East Asia				Projected National Saving Rate			
	Means of the variables			Constant D1		Changing D1	
	q	dq	D1	OLS	2SLS	OLS	2SLS
1950	0.4972		0.4715				
1955	0.5193	0.0220	0.4852	0.2059	0.1997	0.2274	0.2115
1960	0.5349	0.0157	0.4972	0.1996	0.1972	0.2196	0.2082
1965	0.5450	0.0101	0.4854	0.1929	0.1928	0.2143	0.2047
1970	0.5579	0.0128	0.4626	0.2019	0.2051	0.2261	0.2185
1975	0.5718	0.0139	0.4348	0.2084	0.2152	0.2359	0.2303
1980	0.5844	0.0126	0.4015	0.2101	0.2199	0.2416	0.2373
1985	0.5961	0.0117	0.3654	0.2123	0.2251	0.2481	0.2448
1990	0.6077	0.0116	0.3358	0.2158	0.2315	0.2552	0.2532
1995	0.6198	0.0121	0.3147	0.2207	0.2393	0.2625	0.2624
2000	0.6306	0.0108	0.2924	0.2218	0.2431	0.2663	0.2676
2005	0.6413	0.0108	0.2714	0.2253	0.2493	0.2723	0.2752
2010	0.6513	0.0100	0.2527	0.2271	0.2535	0.2763	0.2807
2015	0.6605	0.0092	0.2447	0.2287	0.2574	0.2789	0.2851
2020	0.6691	0.0086	0.2410	0.2304	0.2613	0.2811	0.2893
2025	0.6772	0.0080	0.2419	0.2320	0.2649	0.2826	0.2928
2030	0.6849	0.0077	0.2454	0.2340	0.2688	0.2841	0.2964
2035	0.6924	0.0075	0.2497	0.2359	0.2725	0.2855	0.2999
2040	0.6997	0.0073	0.2536	0.2380	0.2765	0.2871	0.3036
2045	0.7069	0.0071	0.2572	0.2400	0.2803	0.2887	0.3072
(2) Non-West, Non East Asia				Projected National Saving Rate			
	Means of the variables			Non-West, Non East Asia			
	q	dq	D1	OLS	2SLS	OLS	2SLS
1950	0.3716		0.7424				
1955	0.3894	0.0178	0.7717	0.0807	0.0728	0.0716	0.0591
1960	0.4055	0.0161	0.8066	0.0858	0.0830	0.0775	0.0704
1965	0.4213	0.0158	0.8368	0.0913	0.0927	0.0834	0.0811
1970	0.4359	0.0146	0.8434	0.0961	0.1019	0.0890	0.0907
1975	0.4504	0.0145	0.8348	0.1012	0.1107	0.0949	0.1001
1980	0.4656	0.0152	0.8220	0.1068	0.1198	0.0997	0.1092
1985	0.4802	0.0146	0.8069	0.1117	0.1289	0.1038	0.1173
1990	0.4863	0.0061	0.7859	0.1111	0.1347	0.1029	0.1220
1995	0.4911	0.0047	0.7513	0.1123	0.1379	0.1014	0.1227
2000	0.4956	0.0045	0.7103	0.1139	0.1408	0.1013	0.1220
2005	0.5040	0.0085	0.6715	0.1181	0.1449	0.1053	0.1236
2010	0.5153	0.0112	0.6345	0.1230	0.1510	0.1100	0.1281
2015	0.5270	0.0117	0.5984	0.1273	0.1580	0.1138	0.1338
2020	0.5388	0.0118	0.5600	0.1316	0.1652	0.1178	0.1399
2025	0.5516	0.0127	0.5198	0.1363	0.1727	0.1224	0.1464
2030	0.5640	0.0124	0.4808	0.1406	0.1804	0.1266	0.1533
2035	0.5759	0.0119	0.4444	0.1446	0.1877	0.1306	0.1601
2040	0.5872	0.0113	0.4122	0.1485	0.1948	0.1343	0.1667
2045	0.5978	0.0106	0.3848	0.1520	0.2014	0.1378	0.1731

Appendix Table 2 Adult Survival Index and Projected National Saving Rate (Continued)

(3) West				Projected National Saving Rate			
	Means of the variables			Constant D1		Changing D1	
	q	dq	D1	OLS	2SLS	OLS	2SLS
1950	0.5108		0.4334				
1955	0.5322	0.0214	0.4511	0.2091	0.2060	0.2346	0.2201
1960	0.5468	0.0146	0.4612	0.2015	0.2020	0.2259	0.2154
1965	0.5552	0.0084	0.4467	0.1931	0.1956	0.2192	0.2100
1970	0.5658	0.0106	0.4260	0.2006	0.2057	0.2291	0.2215
1975	0.5787	0.0129	0.4040	0.2087	0.2171	0.2399	0.2343
1980	0.5899	0.0112	0.3767	0.2094	0.2206	0.2438	0.2396
1985	0.6003	0.0105	0.3444	0.2114	0.2252	0.2497	0.2463
1990	0.6111	0.0107	0.3208	0.2154	0.2318	0.2565	0.2545
1995	0.6228	0.0117	0.3026	0.2210	0.2404	0.2643	0.2643
2000	0.6331	0.0103	0.2823	0.2217	0.2436	0.2674	0.2688
2005	0.6431	0.0101	0.2612	0.2246	0.2490	0.2729	0.2757
2010	0.6524	0.0092	0.2441	0.2261	0.2528	0.2764	0.2805
2015	0.6610	0.0086	0.2381	0.2278	0.2567	0.2788	0.2848
2020	0.6692	0.0082	0.2363	0.2297	0.2606	0.2810	0.2889
2025	0.6769	0.0077	0.2363	0.2313	0.2641	0.2825	0.2924
2030	0.6844	0.0075	0.2429	0.2334	0.2681	0.2839	0.2959
2035	0.6917	0.0072	0.2478	0.2352	0.2717	0.2851	0.2992
2040	0.6988	0.0071	0.2521	0.2373	0.2756	0.2866	0.3028
2045	0.7058	0.0070	0.2562	0.2395	0.2795	0.2883	0.3064
(4) East Asia				Projected National Saving Rate			
				Constant D1		Changing D1	
	q	dq	D1	OLS	2SLS	OLS	2SLS
1950	0.3429		0.7190				
1955	0.3596	0.0167	0.7066	0.18540	0.15826	0.1804	0.1555
1960	0.3755	0.0158	0.7406	0.18712	0.16557	0.1780	0.1606
1965	0.3909	0.0154	0.7466	0.19127	0.17497	0.1815	0.1696
1970	0.4064	0.0155	0.7098	0.21062	0.20115	0.2052	0.1982
1975	0.4227	0.0163	0.6426	0.20667	0.20234	0.2093	0.2038
1980	0.4380	0.0153	0.5687	0.21482	0.21591	0.2263	0.2222
1985	0.4517	0.0137	0.5070	0.21825	0.22428	0.2371	0.2347
1990	0.4575	0.0057	0.4367	0.21889	0.22918	0.2462	0.2442
1995	0.4590	0.0016	0.3959	0.21863	0.23247	0.2508	0.2502
2000	0.4606	0.0016	0.3583	0.22235	0.23968	0.2590	0.2599
2005	0.4682	0.0076	0.3377	0.22959	0.25075	0.2687	0.2723
2010	0.4796	0.0114	0.3086	0.23363	0.25848	0.2762	0.2820
2015	0.4916	0.0121	0.2871	0.23426	0.26229	0.2794	0.2872
2020	0.5042	0.0126	0.2717	0.23496	0.26577	0.2820	0.2917
2025	0.5181	0.0138	0.2642	0.23666	0.27003	0.2845	0.2965
2030	0.5319	0.0138	0.2619	0.23742	0.27304	0.2856	0.2996
2035	0.5452	0.0133	0.2617	0.24008	0.27793	0.2883	0.3045
2040	0.5579	0.0127	0.2632	0.24239	0.28241	0.2904	0.3089
2045	0.5698	0.0119	0.2636	0.24341	0.28537	0.2914	0.3118