Penn Institute for Economic Research
Department of Economics
University of Pennsylvania
3718 Locust Walk
Philadelphia, PA 19103-6297

pier@ssc.upenn.edu
http://www.econ.upenn.edu/pier

PIER Working Paper 97-010

"Why Are Saving Rates in East Asia So High? Reviving the Life Cycle Hypothesis"

by

Melvyn Cole and Randall Wright

WHY ARE SAVING RATES IN EAST ASIA SO HIGH? REVIVING THE LIFE CYCLE HYPOTHESIS

F. Gerard Adams and Peter A. Prazmowski*

Abstract — Why are saving rates in the East Asian countries so high? This paper represents an attempt to provide an explanation in terms of rapid income growth rates linked to the life cycle hypothesis. Empirical tests support the relationship between saving rates and growth implied by the theory. This approach goes a long way toward explaining high saving rates in East Asia.

Key words: Life Cycle Theory, Mathematical Models, Econometrics, Savings.

I. Introduction

A dominant factor in the "miracle" of East Asian growth has been the extremely high domestic saving and investment rates observed in that part of the world.[1] The high saving rates in the rapidly growing East Asian countries compare to relatively lower saving rates in other parts of the world and in most advanced countries which, coincidentally, are also growing much more slowly.

While there has been much emphasis on the relationship running from high saving to high investment and growth (Horioka [1994], Alexakis [1994], Feldstein and Horioka [1980]), there has been much less concern on the reverse direction, that running from high growth rates to high saving rates (Carroll et. al [1994], Hayashi [1989], Graham [1987]). There has not been a coherent answer to the question: Why are saving rates in the East Asian countries so high?

This paper represents an attempt to provide such an explanation in terms of rapid income growth rates linked to the life cycle hypothesis. Empirical tests support the relationship between saving rates and growth implied by the theory. Other factors appear also to contribute to the explanation. Section II considers the high saving rate and high growth phenomenon in East Asia. Section III provides the theoretical basis for high saving rates and rapid income growth. Section IV investigates the empirical evidence for the life cycle effect and other factors. Section V concludes.

---

* University of Pennsylvania.
This study is part of the collaboration between the International Centre for the Study of East Asian Development (ICSEAD) and the University of Pennsylvania. We would like to acknowlege with thanks the contribution of an anonymous referee.

[1] It goes almost without saying that other factors such as export promotion, foreign direct investment, industrial policy, exchange rates, and macro policies also have played an important role in East Asian development (World Bank [1993]). But high domestic saving and investment rates have been a central growth factor in all the East Asian countries.

I. The High Saving/High Growth Phenomenon In East Asia

Saving (and investment) rates in East Asia have been remarkably high in comparison to patterns observed in the rest of the world. Table 1, a comparison of saving rates in various classes of countries, shows that in the period 1991-92 saving rates in the East Asian high growth countries, what the World Bank [1993] refers to as the HPAEs, exceed 30%, far above other classes of countries.[2]

Table I — High Saving/High Growth Phenomenon

Region	Saving Rate (%) 1992	Growth Rate GDP p.c (%) 1980-92
Low-Income	9	2.0
Middle-Income	20	3.0
Upper Middle-Income	24	2.9
High-Income (OECD)	25	3.1
East Asian Economies	34	4.9
• China	39	7.6
• Indonesia	37	4.0
• Philippines	18	1.0
• Thailand	35	6.0
• Malaysia	35	3.2
• South Korea	36	8.5
• Singapore	47	5.3
• Japan	34	3.6

Source: World Bank World Development Report 1992

The possible explanations range widely: from non-economic justifications related to culture and ethnicity, Crook [1993], demographics and government policies, Doshi [1994], Kim [1993], Meyer [1992], Weil [1991], and Graham [1987], to economic rationales like financial market imperfections, and high interest rates, Makin and Couch [1989], Hall [1988], and Fortune and Ortmeyer [1985].

On a worldwide basis, the empirical relationship between saving rates and growth is substantial. Figure 1a shows saving rates in 1992 and per capita growth rates for the period 1980-1992 for low, middle, upper middle, high income economies and in the East Asia (World Bank definitions). A persistent relationship between saving and growth is apparent. The East Asian countries are characterized by both very high saving rates and rapid long term growth in comparison to other groups. Figure 1a shows this relationship for broad groups of countries. Figure 1b shows this relationship for the 8 individual countries of the East Asian group.

[2] Throughout thus paper we are concerned with gross domestic saving. Alternative concepts, particularly private saving, could also be considered.

Figure Ia—World Wide Saving/Growth

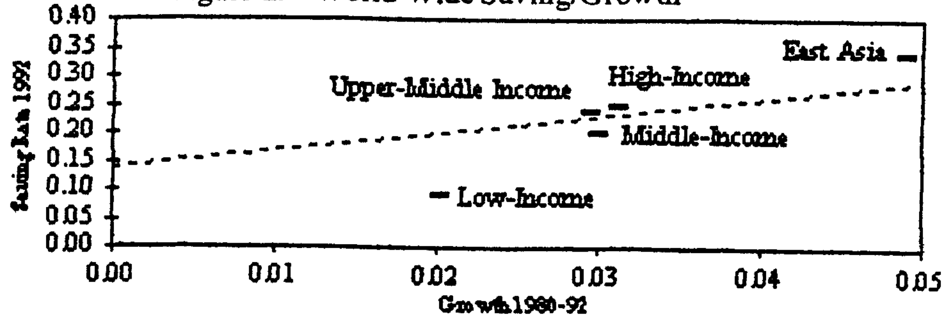
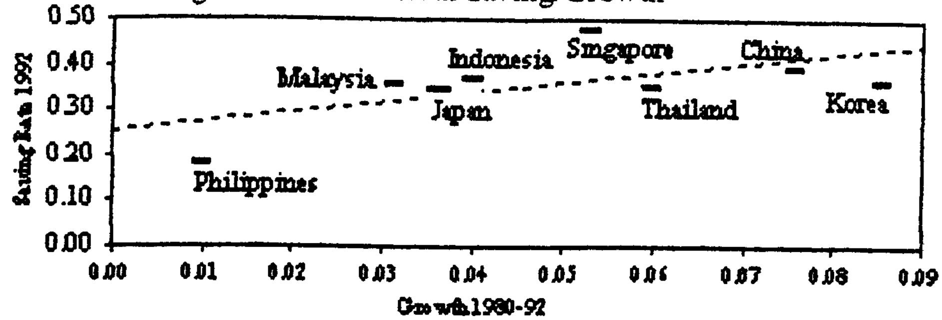


Figure Ib—East Asian Saving/Growth



The Saving-Income Ratio/Growth Relationship[3]

The relationship of saving rates to growth rates, based on 77 selected countries world wide, Table II equation [i], is statistically significant. East Asia lies only a little above the regression line!

Table II—Cross-Sectional Regressions of the Saving-Income Ratio on Growth

Equation	Constant	Growth	R^2	S.E.
(i) World Wide	0.1516	2.4007	0.3075	0.0859
	(15.0523)	(6.1478)		
(ii) East Asia	0.2526	2.0133	0.3762	0.0105
	(2.6005)	(1.9022)		

Data Source: World Bank, World Development Report 1993

Looking at East Asia separately from other parts of the world, equation [ii] and Figure Ib, we observe a similar relationship between saving rates and growth. The relationship is only just statistically significant. In this case, Singapore lies above the regression line and the Philippines and Korea remain substantially below it. As we can see, the difference between the two regressions is not substantial. The fit is relatively good for cross section, but need for a more precise and theoretically based explanation is apparent.

Techniques have been used to test the causality between saving and growth, for example Granger causality tests (World Bank [1993]); however, the implications of a cross-sectional setting require the use of more crafted methods for studying such an association.

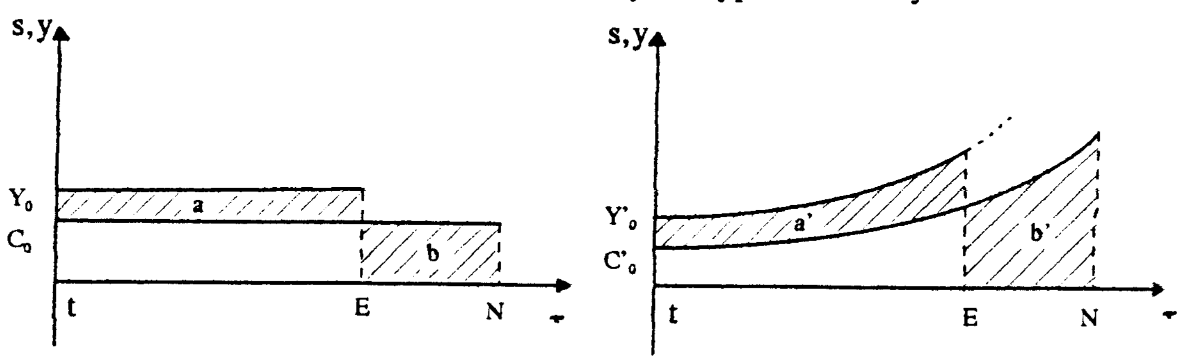
[3] The regression line in Figure Ia pertains to the 77 countries (equation (i) in Table II) with dummies for selected outliers. The regression line in Figure Ib pertains to 8 countries (equation (ii) in Table II).

III. Life Cycle Approaches To Saving And Growth

The positive correlation between saving rates and growth is not new to the literature. The relationship was already noted in the early articles on the life cycle hypothesis by Modigliani and Brumberg [1954], and Swamy [1968] and tested empirically by Houthakker [1965] and Modigliani [1954], [1966], and [1970]. Modigliani concludes on the basis of data for a limited group of countries, not including East Asia, in the 1950's: "In summary, all the evidence supports both quantitatively and qualitatively the role of the two principal variables suggested by the life cycle model, productivity growth of income and the age structure of the adult population." Modigliani [1970, p.219].

The intuition behind the life cycle theory is a life-time budget constraint problem in which individuals tend to determine their consumption or saving levels in terms of some notion about their expected income, retirement age and life expectancy. Economic agents set their current and expected saving-income ratios so to equate life-time income to life-time consumption (Figure IIa) or, to put in another way, setting saving during working life to equal consumption during retirement life. This means that during their working life (*E*) consumers build up an asset balance so that there will be sufficient wealth to finance continued consumption at their chosen level in the retirement period (*R*=*N*-*E*).

Figure IIa and IIb — The Life Cycle Hypothesis: τ = years



In the simplest case of constant income and no interest rate, this yields the familiar rectangular diagram shown in Figure IIa, with the area **a**, representing saving equating area **b** which represents disaving during retirement and C_0/Y_0 = E/N or a saving rate S_0/Y_0=1-E/N. It is important to notice that the notion of aggregate saving we are using here refers to a weighted average of employed people's saving and retired people's saving. This implies, in this case that in an equilibrium age distributed population[4] aggregate saving is zero since the share of aggregate income saved is equal to the share of aggregate income disaved.

[4] Equilibrium in the age distribution implies that the age distribution is stable from one generation to the next.

The introduction of growing per capita income considerably changes the issues. Assume that per capita income is rising at a steady predictable annual rate. The representative consumer participates in this pattern of income growth throughout his/her working life. The question is then with regard to the appropriate assumption about the pattern of consumption expenditures, first, throughout the working life period and, then, throughout the period of retirement from E to N. An important modification of the traditional approach is to recognize that consumption standards in the society rise as income does, and that they continue to rise even after the consumer's retirement. Consumers will probably want to maintain a level of consumption that remains constant **relative** to the average consumption in the society. This recalls the relative income hypothesis, Duesenberry [1949], or its cross-section version, Brady and Friedman [1949]. This implies that consumers seek to maintain the same steady rate of growth for consumption as the growth of per capita income of society, throughout not only the working period but the retirement period as well. Graphically this is shown in Figure IIb where the area **a'** must equal area **b'**. As growth persists during retirement, the amount of saving required to fulfill such higher levels of consumption should increase and hence individuals adjust their saving-income ratios upward so to create more saving during working life and less consumption during retirement life (Figure IIb). [5] The result is a positive relationship between saving and growth. Even in age distribution equilibrium, total saving that needs to be done today exceeds disaving for present retirement. In the case that the population is not in age distribution equilibrium (i.e., population is predominantely young), aggregate saving will be higher than dissaving due to the growth effect, and still higher due to the age distribution effect.

Mathematically, this story can be developed as follows. Following Modigliani-Brumberg's procedure [1954], we start from the theory of consumer choice. It will be assumed the individuals plan to consume their lifetime resources in equal proportions throughout their life and that no bequest motive is present in their saving decisions. It is also assumed that a growth rate g and an interest rate r are present in this economy, implying that the individual's income is growing exponentially at $1+g$, and also that interest is earned on saved assets. Finally, rationality will be assumed with respect to future levels of growth and income. This implies that individuals make accurate guesses about the state of the economy as well as with respect to their personal finances.

The consumer problem becomes the maximization of $U(c_t, c_{t+1}, \ldots, c_{t+N}, w_{N+1})$ subject to a life time resources budget constraint.

[5] Even in the case that consumption remains fixed during retirement the saving pattern in a rapidly growing economy will be higher than in a slow growing economy. The reason lies in the fact that the retirement period is shorter than the working period of the savers' life. By the time the consumer reaches retirement age and consumption stabilizes, the growth factor is already strong, given its exponential nature.

Here, U is a monotonic increasing function, homogenous in $c_t, c_{t+1}, \ldots, c_{t+N}$, and the budget constraint is given by

$$w_t + \sum_{\tau=t}^{E} \frac{y_\tau}{(1+r)^{\tau+1-t}} + \sum_{\tau=t}^{E} \frac{s_\tau \cdot r^{E+1-\tau}}{(1+r)^{\tau+1-t}} = \frac{w_{N+1}}{(1+r)^{N+1-t}} + \sum_{\tau=t}^{N} \frac{c_\tau}{(1+r)^{\tau+1-t}} , \tag{1}$$

where E and N are the earning span and the natural life span, c is aggregate consumption, s is aggregate saving, y is national income and r is the interest rate. y_τ, c_τ, and s_τ behave as exponential functions with g as the growth parameter. These parameters are expected to remain constant along the balance of the individual's life.

After maximizing U subject to (1), the first order maximum conditions are obtained

$$\begin{aligned} &\frac{\partial U}{\partial c_\tau} - \lambda(1+r)^{-\tau-1+t} = 0 \\ &\frac{\partial U}{\partial W_{N+1}} - \lambda(1+r)^{-N-1+t} = 0 \end{aligned} , \tag{2}$$

where λ is the Lagrange multiplier and $\tau = t, t+1, \ldots, N$. The solution to this system of equations, after substituting for the values of y_τ and s_τ, is of the form

$$c_\tau = \alpha\left(w_t + \sum_{\tau=t}^{E} \frac{y_t(1+g)^{\tau+1-t}}{(1+r)^{\tau+1-t}} + \sum_{\tau=t}^{E} \frac{s_t(1+g)^{\tau+1-t} r^{E+1-t}}{(1+r)^{\tau+1-t}} \right) \quad \text{or} \quad c_\tau = \alpha\ v_\tau , \tag{3}$$

where v_τ represents total resources at time τ, and α and v_τ are time independent. Following Modigliani-Brumberg [1954], the marginal propensity to consume α is treated as time invariant. The consumer problem implies that the individual plans to set α so that to equate life-time resources to life-time consumption, or put it differently, equating saving during the earning life plus asset returns during the life span to consumption during retirement. Given that α is constant across time and assuming $w_t = 0$, we can solve the constraint problem. Rewriting (1) to have only saving and consumption, we get

$$\sum_{\tau=t}^{E} \frac{s_t(1+g)^{\tau+1-t}(1+r)^{E+1-\tau}}{(1+r)^{\tau+1-t}} + \sum_{\tau=t}^{E} \frac{c_t(1+g)^{\tau+1-t}}{(1+r)^{\tau+1-t}} = \sum_{\tau=t}^{N} \frac{c_t(1+g)^{\tau+1-t}}{(1+r)^{\tau+1-t}} \tag{4a}$$

or, after rearranging

$$\sum_{\tau=t}^{E} \frac{s_t(1+g)^{\tau+1-t}(1+r)^{E+1-\tau}}{(1+r)^{\tau+1-t}} = \sum_{\tau=E+1}^{N} \frac{c_t(1+g)^{\tau+1-t}}{(1+r)^{\tau+1-t}} \tag{4b}$$

Equation (4b) implies that saving during the earning span must be equal to consumption during retirement. Evaluating (3) at time t, using the approximation that saving depends on life-time resources, namely $s_t = (1-\alpha)v_t$, and substituting into (4), the budget constraint becomes

$$\sum_{\tau=t}^{E} \frac{(1-\alpha)v_t(1+g)^{\tau+1-t}(1+r)^{E+1-\tau}}{(1+r)^{\tau+1-t}} = \sum_{\tau=E+1}^{N} \frac{\alpha v_t(1+g)^{\tau+1-t}}{(1+r)^{\tau+1-t}} \tag{5}$$

The solution to equation (5) is the following conditional system.[6] In the case that the growth rate is different from the interest rate, the solution becomes

$$\alpha = \frac{(1+g)^E(1+r)^{-E} - (1+r)^E}{(g-2r)\left[\frac{(1+g)^N(1+r)^{-N} - (1+g)^E(1+r)^{-E}}{g-r} + \frac{(1+g)^E(1+r)^{-E} - (1+g)^E}{g-2r}\right]} \tag{5a}$$

If both the growth rate and the interest rate are equal to some non-zero constant i.e.,$(g = r = \rho)$, (5a) breaks down and the solution in the limit becomes

$$\alpha = \frac{1-(1+\rho)^E}{1-\rho N-(1+\rho)^E+\rho E} \tag{5b}$$

In the case that the constant value in (5b) is zero i.e.,$(g = r = \rho = 0)$, the solution becomes Modigliani's original case; namely

$$\alpha = \frac{E}{N} \quad \text{or} \quad S = 1-\frac{E}{N} \tag{5c}$$

The saving equation follows from (3).Substituting the saving-income ratio 'α' in (3) for its equivalent given by (5a-5b), we have the following saving-income ratio equation

$$S^i = a'_0 \hat{S}^i + \upsilon_t \tag{7}$$

where $S^i = s^i/y^i$, $a'_0 = 1$ *and* $\hat{S}^i = (1-\alpha^i)$, and where, α^i is defined by equation (5a), (5b) or (5c) depending on the restrictions imposed on growth and interest. The cross section error component is $\upsilon_t \sim N(0,\sigma^2_\upsilon)$. Note that we have added country superscripts, since we expect to test this model on a cross-section framework. By way of illustration, if we

[6] Due to the complexity of equation (5), a continuous budget constraint identity was used. The following integral identity results

$$\int_t^E (1-\alpha)\mathrm{EXP}[(g-2r)\tau + rE]d\tau = \int_E^N (\alpha)\mathrm{EXP}[(g-r)\tau]d\tau, \tag{5'}$$

The conditional system in (5a-5c) results after applying L'Hopital's rule to the solution in (5') since the original solution has undefined limits when either g and/or r tend to zero. The final solution was then converted into a discrete structure.

assume a working life of 38 years, a natural life of 50 years, and a growth rate equal to zero, the expected saving rate would be $1\text{-}E/N = 0.24$.

The introduction of growth and interest rates yields values of $\hat{S}^i$ ranging from 36% at a growth rate of 1% to 83% at a growth rate of 10% assuming a zero interest rate and from 3% at a growth rate of 1% to 30% at a growth rate of 10% assuming an interest rate of 5%. The relationship is non linear.

To obtain an aggregate savings rate (S), an average of the saving rate of working people and the dissaving of retired people, we assume that our economies are composed of n individuals of whom ny are working and $1\text{-}ny$ are retired. The workers save and the retirees dissave. Note that because of our earlier assumptions about the consumption path, the rate of dissaving among the old is just $1\text{-}\hat{S}^i$.

Therefore

$$\Psi^i = \sum_i^n S_j^i = a'_o\left[\hat{S}^i \cdot (ny/n) - \left(1 - \hat{S}^i\right) \cdot (1 - ny/n)\right], \tag{8}$$

or

$$\Psi^i = a'_o\left[\hat{S}^i + (ny/n) - 1\right], \tag{9}$$

The aggregate saving rate is a linear function of $\hat{S}^i$ and of the dependency rate, wich is defined here as $1\text{-}ny/n$.

IV. Data and Empirical Evidence

Our purpose is to test the importance of growth on the saving function, with particular relevance to the East Asian countries. If our theoretical approach is correct, we would expect in a regression of S^i on $\hat{S}^i$ in cross section data, the coefficient of the $\hat{S}^i$ variable (the calculated saving-income ratio) to be close to unity indicating the applicability of the life cycle approach in capturing the saving process.

Before we proceed with the analysis, some comments on the data and its robustness are in order. A cross-sectional data set was gathered for 77 countries. The values consist of the saving rates, growth rates, interest rates, average working life and natural life for the countries in the sample. Additionally, data on the dependency ratio, income distribution and specific dummy variables were also gathered. Four main sources where used: the 1994 *World Bank Tables*, 1974 *World Population Year Book*, *World Mortality Tables*, and 1995 Summers and Heston *Penn World Tables*. The saving rate, growth rate and interest rate came from the first source, the average working life, which is an estimated average measurement for the year 1995-2000, came from the second source, [7]

[7] The data are given as averages for the period 1980-1990 for selected world regions (e.i. East Asia).

life expectancy was obtained from the 1994 mortality tables for selected countries and regions. The remaining variables where gathered from the Summers and Heston M5 table.

The interest return on accumulated capital, plays an important role in influencing life cycle saving. The higher the interest return on accumulated savings the less the share of income that must be saved to achieve retirement income objectives. This has been incorporated into our theoretical measure of the saving rate, $\hat{S}^i$. But a critical question is what interest rate to use. Presumably, the interest rate should be a return on savers' capital, a real long term rate. We began by computing different interest rates for all countries subtracting the rate of inflation from the nominal long term interest rate. Unfortunately, for many countries this yields strange values, many of them negative, as long term interest rates fail to reflect inflationary pressures.[8]

We then assumed, in the computation of $\hat{S}^i$, that all countries had a common long term interest rate of 3%. The difficulty with this approach, however, was that it created two classes of countries, the low and middle income developing countries with values of $\hat{S}^i$ that are systematically higher than actual values and also the high income industrialized countries. As a consequence, this assumption affected the coefficient and the explanatory power of the model (equation [ii] in Table III). Finally, recognizing that long term real interest rates are higher in developing countries than in industrialized countries, reflecting the higher risk in the former, we computed $\hat{S}^i$ assuming a real long term interest rate of 2% for the countries in the World Bank "high income" classification, 3% for the "middle income" group and 4% for the "low income" classification (equation [iii] in Table III).[9]

Most of our data is probably subject to large measurement errors due to their complexity and reporting problems. However, what is available is sufficient to create a clear picture of our objective and the direction of our analysis. In the future, when more detailed and robust data becomes available, the fit of our model could be improved, although the conclusions, we believe, will remain unaltered.

We start our analysis by testing the relevance of growth. This was done by comparing three equations, one using Modigliani's original approach (no growth, no interest), and the others using $\hat{S}^i$, evaluated at each country's growth rate, the relevant assumptions on the interest rate and data on both the average working life as well as the average retirement period for each country.

We correlated the observed saving rate 'S^i' with alternative values of the computed saving rate. Equation [i] in Table III, the empirical formulation relating the saving rate to working life (E) and total life (N), has limited explanatory power. The coefficient is about

[8] Similar problems are noted in World Bank [1993, p. 205-207].

[9] Such an approach is supported by a cross-section regression of real interest rates on per capita income (Summers/Heston figures). This regression shows a negative relationship between the real interest rate and per capita GDP, though the variations around the regression line are quite wide.

0.5 and even though statistically significant, the fit is quite poor. Equations [ii] and [iii] in Table III, test the relevance of growth in this model. Equation [ii] assumes country specific growth rates and estimates of E and N, with a 3% real interest rate for all countries. Equation [iii], which refers to $\hat{S}^i$ based on growth, our 2%, 3% and 4% assumptions on interest rate and estimates of E and N, is in every sense, statistically superior to [i] and [ii]. The most striking aspect of equation [iii] is that the coefficient of the $\hat{S}^i$ variable is near unity (not significantly different from 1.0).

Table III —Regressions of the Saving-Income Ratio on $\hat{S}^i$.

Equation	(a)	(b)	(c)	R^2	S.E.
Complete Sample					
(i)	0.5015 (15.7787)			0.0734	0.1024
(ii)		1.2918 (18.1689)		0.2586	0.0916
(iii)			1.0382 (20.4685)	0.3917	0.0829
East Asia					
(iv)	1.3006 (9.6340)			0.1734	0.0966
(v)			1.0125 (10.3342)	0.4240	0.0750

Note: t statistics in parenthesis

a. Modigliani's original case ($g = r = 0$).

b. Calculated saving-income ratio evaluated at a constant 3% interest for all countries.

c. Calculated saving-income ratio evaluated at the 2%, 3% and 4% interest assumptions.

Covering only the much smaller number of countries (8) in East Asia, again $\hat{S}^i$ also has a coefficient near unity, especially equation [v]. The results of these regressions show a significant statistical relationship between S^i and $\hat{S}^i$ in all cases, with R^2 ranging from 0.3917 in the case of all the countries (equation [iii]). to 0.4240 in the case of the East Asian sample only (equation [v]).

Even though equations [iii] and [v] model the data quite well, they suggest the need for additional structure. Several factors might affect the saving rate in addition to the elements included in $\hat{S}^i$. Table IV contains the results of some statistical tests. As a benchmark, equation [iii] in Table III is shown as equation [i] in Table IV. First, we might expect that short term movements in income might affect the saving pattern in addition to the long term expectations. If sudden changes occur in short run growth, we would expect agents to adjust their consumption/saving decision gradually reflecting uncertainty about future income. We tested this hypothesis using a short term growth variable (per capita growth of GDP from 1991 to 1992). The result (equation [ii] in Table IV) indicates that if a particular country has experienced a recent change in its growth rate, individuals in that economy adjust saving slowly and we get a coefficient on the change in income

Table IV
Regression of $\hat{S}$ on some variables[a]

Equation	$\hat{S}$ [b]	S_{t-1} [c]	$\%\Delta Y_{1991-1992}$ [d]	Ypc1980 [e]	DEA [f]	DLI [ff]	DMI [ff]	DUI [ff]	ADR65 [h]	YDIS80 [i]	$\bar{R}2$	S.E.
(i)	1.0382											
	(20.4685)										0.3917	0.0829
(ii)	0.9781		0.1273								0.4123	0.0815
	(16.6097)		(1.9161)									
(iii)	0.1762	0.8444									0.7830	0.0495
	(2.2213)	(11.7564)										
(iv)	0.9248					0.0335	0.0803	0.0139			0.5230	0.0734
	(16.2314)					(2.1113)	(4.5761)	(0.5679)				
(v)	0.9886				0.0553						0.4047	0.0821
	(16.8629)				(1.6330)							
(vi)	0.9635			0.0427							0.4882	0.0779
	(14.9449)			(1.6689)								
(vii)	0.8342								0.4433		0.5990	0.0664
	(11.9073)								(3.0186)			
(viii)									1.9071		0.2670	0.1180
									(12.6095)			
(ix)	0.7971									0.1466	0.6466	0.0643
	(10.8841)									(4.0534)		

Note: Figures in parenthesis are t statistics.

a. Regressions based on 77 countries world wide. Estimation using OLS.

b. Refer back to equation (iii) in Table III.

c. Lagged saving-income ratio (1991 figures).

d. Percentage change in per capita income (1991-1992).

e. GDP per capita in 1980.

f. Dummy variable for East Asian Countries (1 if category, 0 otherwise).

ff. Dummies for low income (DLI), middle income (DMI) and upper middle income (DUI) economies (1 if category, 0 otherwise).

g. Age distribution variable: DPR=% of population <= age 15+% of population >= age 65/AGED.

h. Age dependency variable: 1-ny/n. Where n=%working population (ny), plus %retired population (65+).

i. Income distribution gap: Difference between the income held by the population in the highest and lowest 20%. Equation based on a smaller sample of 52 countries.

variable of 0.1273. Similar results are obtained with a dynamic adjustment model (equation [iii] in Table IV). A gradual adjustment is present in the way individuals make saving decisions. We used the lag saving-income ratio to test such a hypothesis. The result shows a coefficient on $\bar{S}^i$ of 0.1762. The calculated long term coefficient on a worldwide basis is roughly equal to one (1.0034).

A second issue, is whether there are effects related to regions and development status. We used dummy variables to test interaction effects on the basis of the development status of the countries. A dummy for low income developing (LD) countries, that takes the value of one if the country has LD status and zero otherwise, was tested. The same was done for middle income developing and upper-middle income developing countries using the high income economies as a benchmark. The result, equations [iv] in Table IV, indicates that the middle income developing economies fall significantly above the mapping of S^i on $\bar{S}^i$. The low income countries fall below the line, but the coefficient is at the margin of significance.

When we tested to see if there was something special about the East Asian countries, the East Asian dummy was only marginally significant at the 10% level (equation [v] in Table IV). The results suggest that special characteristics do not account for much of the saving behavior of East Asia.

We turn next to the possibility that saving behavior could be influenced by the wealth status of the countries involved. Unfortunately, there are no accessible comparable figures for wealth. As a proxy, we have used per capita income at the start of our estimation period, 1980 (Summers and Heston, *Penn World Tables*). The result (equation [vi] in Table IV) does not support an effect, though calculations based on more sophisticated measures of initial wealth holdings would be in order.

The question of the age distribution was raised in the initial work of Modigliani, (Modigliani [1970]). If population is out of equilibrium, in the sense that there is a preponderance of dependents or dissavers, we would anticipate that the aggregate saving rate would be reduced. A negative relationship between the share of dependents or of retired older people and the saving rate may be expected. We have used a variable named ADR65, to represent the age dependency ratio of the old (age > 65) to the total population ($1\text{-}ny/n$). Surprisingly, the result (equation [vii], Table IV) suggests that saving rates are higher, the greater the dependency ratio. The dependency ratio for old people is high in the high income industrialized countries, where population and income growth are lower and vice versa. This variable appears to be capturing special characteristics of certain groups of countries, rather than the effect of demographic disequilibrium. Further analysis suggests that dependency ratios are closely related to development and region.[10] A regression of the saving/income ratio on the dependency ratio (equation [viii], in Table IV), also proved significant and of the same direction. However, with very low prediction power.

Finally, regarding income distribution effects, past studies support the fact that saving is positively affected by unequal distribution of income. To test this effect, we have used a variable that measures the gap in the income distribution by computing the difference between the percentage of the population in the highest and the lowest brackets (20%) of income holdings. The greater the gap, the more unequal the distribution of income.

The result (equation [ix], in Table IV) significantly supports the theory. The coefficient of $\hat{S}^i$ was not greatly affected. We also tried several other variables (not shown) including trade balances, agricultural value added, and government deficit. However, none of them had significant impact on saving beyond what is included in $\hat{S}^i$.

V. Conclusions

The major empirical results, may be summarized as follows:

• The life cycle approach in a growth and interest return environment appears to give a good description of the fundamental determinants of national saving rates on a world-wide basis and in East Asia.

• From that perspective the saving rates observed in East Asia are not unusually high. A dummy variable for that part of the world yields a marginally significant coefficient.

• As we anticipated other considerations also help to explain differences in saving rates. In particular we note:

-The gradual adjustment of saving rates captured by the changes in per capita income and the lag saving rate variable. This is to be anticipated given the strong assumptions about anticipated income flows made in our calculation of the $\hat{S}^i$ variable.

-The impact of age distribution already noted by Modigliani [1970]. However, our cross-sectional approach has led to an interpretation problem.

-The effects of unequal income distribution, which as expected has a significant positive effect on saving.

[10] Such a result is not untypical in cross section data (Gersovitz [1988]). On the other hand, in time series matéial, Harrigan [1995] finds an important dependency effect.

These findings have important implications for East Asia and more broadly, for worldwide development perspectives. If high saving rates are associated with rapid growth, we may think of the development process as a virtuous circle. Rapid growth rates account for high saving which in turn account for rapid growth. This is certainly the picture we observe in East Asia, with high saving rates contributing to rapid growth. The potential for development, in other parts of the world, may depend critically on whether a growth momentum can be created, one that is anticipated by consumers and that motivates their saving behavior.

Finally, the saving phenomenon described here also helps to explain the slowing of saving rates as countries mature. As the accumulation of capital encounters diminishing returns and as countries approach the limits of best practice technology, growth (and anticipated growth) will slow. With slower growth, will come lower saving rates and in turn still slower growth.

University of Pennsylvania.

REFERENCES

Alexakis, Panayotis and Nicholas Apergis. (1994). "The Feldstein-Horioka Puzzle and Exchange Rate Regimes: Evidence from Cointegration Tests". *Journal of Policy Modeling.* v.16n.5, p. 459-472.

Brady, D. S and R. D Friedman. (1949). "Saving and the Income Distribution", *Studies in Income and Wealth,* vol. x, p. 247-65.

Carroll, Christopher D., David N. Weil, & Michael Kremer. (1994). "Saving and Growth: A Reinterpretation". *Carnegie-Rochester Conference Series on Public Policy,* v.40, p. 133-179.

_________________., B. Rhee, & C. Rhee. (1994). "Are There Cultural Effects on Saving? Some Cross-Sectional Evidence". *Quarterly Journal of Economics.* vol. CIX:3. p. 685-699.

Crook, Olive. (1993). "The Japanese Economy: Thrift and Enterprise". *Economist.* v.326n.7801, pss10-ss12 (UK ss10-2214).

Doshi, Kolila. (1994). "Determinants of the Saving Rate: An International Comparison". *Contemporary Economic Policy.* v.12n.1, p. 37-45.

Duesenberry, J. S. (1949). *Income, Saving and the Theory of Consumer Behavior,* Cambridge: Harvard University Press.

Feldstein, M. and C. Horioka (1980). "Domestic Saving and International Capital Flows". *Economic Journal.* 90, p. 314-329.

Fortune, Peter & David L. Ortmeyer (1985). "The Role of Relative Prices, Interest Rates and Bequests in the Consumption Function". *Journal of Macroeconomics*. v.7n.3, p. 381-400.

Gersovitz, T. M. (1988). "Saving and Development" in Chenery, H. and T.N. Srinivasan. London: Clarendon, K.D. Kurihara, ed., New Brunswick: Rutgers University Press, *Handbook of Development Economics*, vol.1, Amsterdam. NorthHolland.

Graham, John W. (1987). "International Differences in Saving Rates and the Life Cycle Hypothesis". *European Economic Review*, v.31n.8, p. 1509-1529.

Harrigan, Frank. (1995). "How Much Do We Know About Private Saving in South East Asia?" unpublished paper presented at ICSEAD Conference, Kitakyushu, Japan.

Hall, Robert E. (1988). "Intertemporal Substitution of Consumption". *Journal of Political Economy*. v96n2, p. 339-357.

Hayashi, Fumio. (1989). "Is Japan's Saving Rate High? ". *Federal Reserve Bank of Minneapolis Quaterly Review*. v.13n.2, p. 3-9.

Horioka, Charles Y. (1994). "Japan's Consumption and Saving in International Perspective". *Economic Development and Cultural Change*. v.42n.2, p. 283-316.

_______________. (1986). "Why is Japan's Private Saving Rate So High?". *Finance and Development*. v.23n.4, p. 22-25.

Houthakker, H. S. (1965). "An International Comparison of Personal Saving". *Bulletin of the International Statistical Institute*, vol. 38, pp. 56-59.

Kim, Sun Bae (1993). "Do Capital Controls Affect the Response of Investment to Saving?". Evidence from the Pacific Basin. *Federal Reserve Bank of San Francisco Economic Review*. ni, p.23-39.

Makin, John H. & Kenneth A. Couch. (1989). "Saving, Pension Contribution, and the Real Interest Rate". *Review of Economics and Statistics*. v.71n.3, p. 401-407.

Meyer, Stephen A. (1992). "Saving and Demographics: Some International Comparisons". *Business Review* (Federal Reserve Bank of Philadelphia). p. 12-23.

Modigliani, F., (1970). "The Life Cycle Hypothesis of Saving and Inter-Country Differences in the Saving Ratio", p. 197-225 in Ellis, Wia, M.FG. Scott and J. N. Nolfe (Eds.) *Induction, Growth and Trade, Essays in Honor of Sir Roy Harrod*. London: *Clarendon*.

____________. (1966). "The Life Cycle Hypothesis of Saving, the Demand for Wealth and the Supply of Capital". *Social Research*. v33nI. p.160-217.

Modigliani, F., and F. Brumberg. (1954). "Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data", in *Post-Keynesian Economics*, D. K. Kurihara, New Brunswick.

Summers, R. and A. Heston. (1994), Penn World Tables (Mark 5.6a) (computer sofware), Philadelphia: University of Pennsylvania.

Swamy, S. (1968). "A Dynamic Personal Saving Function and its Long Run Implications". *Review of Economics and Statistics*. vol. XLX. p. 111-116.

Weil, David N. (1991). "What Determines Saving: A Review Essay". *Journal of Monetary Economics*. v.28n.1, p. 161-170.

World Bank. (1993). *The East Asian Miracle: Economic Growth and Public Policy*. New York, Oxford University Press.