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The Chinese Saving Puzzle and the Life-Cycle Hypothesis

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1. *Introduction*

With today's world economy plagued by recession and sluggish performance, China stands out with its sustained high growth, perhaps due to market-oriented economic reforms that began in 1978. The growth has been accompanied by an explosion in China's household saving ratio, which has reached an impressive level in recent years, just when there has been a worldwide reduction in the private saving ratio. In 1994, for example, our estimate of the household saving-to-income ratio in China was close to 34 percent, rivaling the Japanese experience in the 1960s, even though the level of China's per-capita income remained well below those of the industrialized nations (see figure 1). More surprisingly, looking back at the postwar history of Chinese household savings, one finds that, from the 1950s through the mid-70s, the "thrifty" Chinese were not so thrifty with an average household saving ratio below 5 percent. In this paper, we attempt to explain the apparent paradox of the sudden spurt in the saving ratio's magnitude by using the framework of the life-cycle hypothesis (LCH) developed by Franco Modigliani and R. Brumberg (1954).

The LCH was initially thought to be relevant for developed market economies only. China's per-capita income in 2002 is still ranked below 100th in the world, according to the World Bank.[2] In the middle of our sample, there was a sharp regime shift from a highly planned economy to a market-oriented economy. Therefore, testing the explanatory power of the LCH for China is not only relevant in endeavoring to offer a plausible explanation of the drastic changes in the personal saving ratio of that country, but also has theoretical implications as to the applicability of the LCH model to a more general environment, including developing countries.

Since it is widely believed that the standard Keynesian theory may play an important part in explaining behavior pertaining to saving in at least the low-income nations, we

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Editor's note: In submitting this paper to the *Journal of Economic Literature*, Franco Modigliani wrote, "This is a paper which has special meaning for me, as I see it as a fitting conclusion to my life's work on saving." Professor Modigliani passed away on September 25, 2003.

Note by Larry Cao: I am deeply saddened that I have lost a mentor but take comfort in knowing that he saw the completion of this project. Franco remained active till the end. On September 20, when we last spoke, he mentioned an additional change he wanted to make. We thank Irene Y. Chan and Francesco Franco for help with data and editing, and Olivier Blanchard, the editor, and an anonymous referee for helpful comments.

I also thank Chen Yuan and Li Ruogu for supporting this project.

[2] World Development Indicators database, World Bank, July 2003.

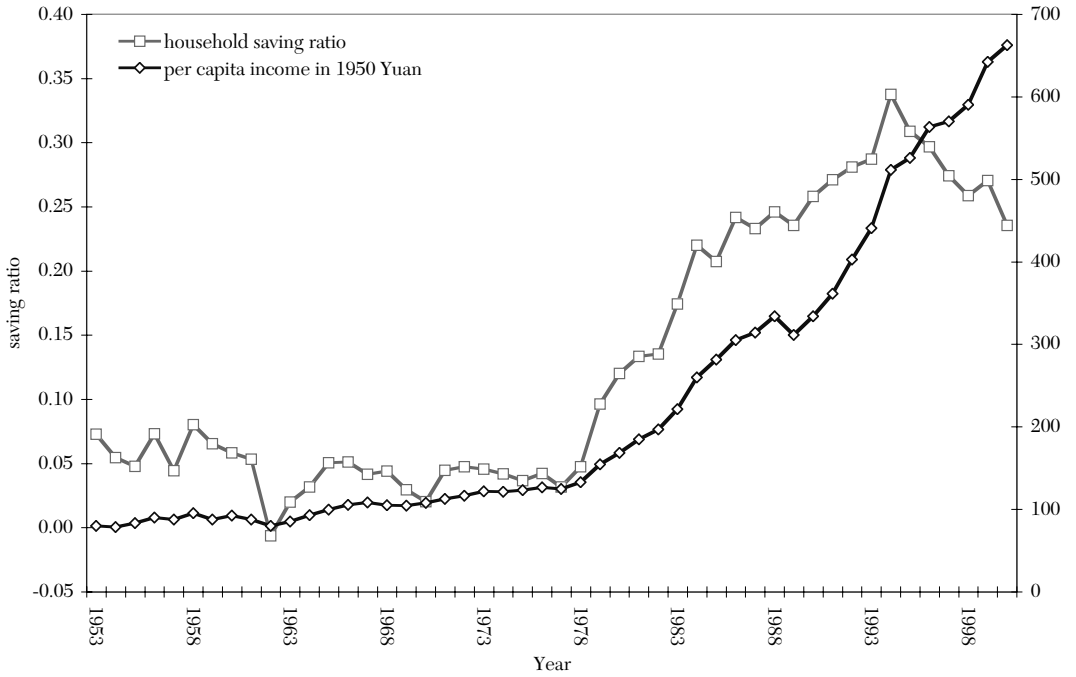

Figure 1: China's Household Saving Ratio and Per-Capita Income: 1953–2000

include a comparison of the results of the LCH and the Keynesian model.

2. *Basic Data*

Table 1 summarizes the income and saving information on China for the period 1953 to 2000. It is important to keep in mind that personal saving (see data appendix) is not measured as (disposable) income minus consumption as is conventional in the national incomes account (NIA). This is due to the unavailability of the required data. In this case, we use an alternative approach that, conceptually, should yield an estimate of NIA saving, except for measurement errors. It consists of measuring the (annual) increase in personal wealth that results from personal saving. Our estimated calculations to show the increase in personal wealth, $W(t)–W(t–1)$, are the sum of two components:

1. The first is the increase in the holdings of a list of intangible assets, $A(t)–A(t–1)$. We have endeavored to make the list of relevant assets as comprehensive as possible, a task facilitated by the very limited choices available during the period we cover. The assets we include consist basically of nominal assets (money, deposits, and government bonds).

2. The second component is an estimate of the increase in the stock of some major tangibles (e.g. private residences). Here we measure the utilization of saving by the estimated flow of investment I^*.

Thus, $S = [A(t)–A(t–1)] + I^* = I + e$, where I is the aggregate investment.

The last equality is meant to emphasize that our measure of saving is logically equivalent to the traditional one, but that the two estimates can differ because of errors of measurement in either or both terms.

Our measure of income is obtained by combining sums for consumption, for which official estimates are available, with sums for saving as estimated above. This approach measures "disposable" income, which is actually very close to personal income, since

Table 1
Chinese Household Income and Saving, 1953 – 2000

Year	Household Consumption	Household Saving	Household Income	Household Saving Ratio	CPI, 1950 = 100	CPI, Preceeding Year = 100	Real Income	Per capita Real Income	E/M
1953	529.20	41.50	570.70	0.0726	121.4	105.1	470.1	79.95	1.0015
1954	550.00	31.80	581.80	0.0546	123.1	101.4	472.6	78.42	0.9876
1955	602.00	30.10	632.10	0.0476	123.5	100.3	511.8	83.27	0.9796
1956	646.80	51.00	697.80	0.0731	123.4	99.9	565.5	90.01	0.9774
1957	686.60	31.80	718.40	0.0442	126.6	102.6	567.4	87.76	0.9705
1958	724.00	63.00	787.00	0.0801	125.2	98.9	628.6	95.26	1.0528
1959	691.20	48.20	739.40	0.0652	125.6	100.3	588.7	87.60	1.0067
1960	741.70	45.80	787.50	0.0581	128.8	102.5	611.4	92.34	1.0001
1961	816.70	45.90	862.60	0.0532	149.6	116.1	576.6	87.55	0.9840
1962	838.70	-5.30	833.40	-0.0063	155.3	103.8	536.7	79.75	0.9432
1963	844.20	17.20	861.40	0.0199	146.1	94.1	589.6	85.23	0.9341
1964	889.60	29.10	918.70	0.0317	140.7	96.3	652.9	92.62	0.9669
1965	951.50	50.70	1002.20	0.0506	139.0	98.8	721.0	99.40	0.9740
1966	1021.10	54.90	1076.00	0.0510	137.3	98.8	783.7	105.13	0.9925
1967	1081.50	46.90	1128.40	0.0415	136.4	99.4	827.3	108.32	1.0085
1968	1076.60	49.40	1126.00	0.0439	136.5	100.1	824.9	105.04	1.0234
1969	1127.70	34.40	1162.10	0.0296	137.8	101.0	843.3	104.54	1.0394
1970	1206.90	24.90	1231.80	0.0202	137.8	100.0	893.9	107.71	1.0502
1971	1262.00	59.20	1321.20	0.0448	137.7	99.9	959.5	112.57	1.0676
1972	1334.20	66.50	1400.70	0.0475	137.9	100.2	1015.8	116.52	1.0524
1973	1432.50	68.40	1500.90	0.0456	138.0	100.1	1087.6	121.91	1.0507
1974	1467.00	64.00	1531.00	0.0418	138.9	100.7	1102.2	121.31	1.0474
1975	1528.50	57.90	1586.40	0.0365	139.5	100.4	1137.2	123.04	1.0457
1976	1588.50	70.20	1658.70	0.0423	139.9	100.3	1185.6	126.51	1.0704
1977	1647.80	53.60	1701.40	0.0315	143.7	102.7	1184.0	124.67	1.1034
1978	1759.10	87.60	1846.70	0.0475	144.7	100.7	1276.2	132.58	1.1400
1979	2005.40	213.90	2219.30	0.0964	147.4	101.9	1505.6	154.35	1.1804
1980	2317.10	316.00	2633.10	0.1200	158.5	107.5	1661.3	168.31	1.2317
1981	2604.10	401.30	3005.40	0.1335	162.5	102.5	1849.5	184.81	1.2761
1982	2867.90	449.10	3317.00	0.1354	165.8	102.0	2000.6	196.81	1.3265
1983	3182.50	671.20	3853.70	0.1742	169.1	102.0	2278.9	221.24	1.3990
1984	3674.50	1036.00	4710.50	0.2199	173.7	102.7	2711.9	259.87	1.4964
1985	4589.00	1199.40	5788.40	0.2072	194.4	109.3	2977.6	281.30	1.5773
1986	5175.00	1649.50	6824.50	0.2417	208.0	106.5	3281.0	305.19	1.6393
1987	5961.20	1811.60	7772.80	0.2331	226.3	107.3	3434.7	314.25	1.6889
1988	7633.10	2489.50	10122.60	0.2459	273.1	118.8	3706.6	333.85	1.7620
1989	8523.50	2624.40	11147.90	0.2354	317.6	118.0	3510.0	311.44	1.7722
1990	9113.20	3168.90	12282.10	0.2580	321.7	103.1	3817.9	333.93	2.0185
1991	10315.90	3835.00	14150.90	0.2710	338.1	103.4	4185.4	361.36	2.0081
1992	12459.80	4868.50	17328.30	0.2810	367.2	106.4	4719.0	402.75	2.0048
1993	15682.40	6313.40	21995.80	0.2870	421.2	114.7	5222.2	440.63	2.0000
1994	21230.00	10813.50	32043.50	0.3375	522.7	124.1	6130.4	511.50	2.0063
1995	26944.50	12027.20	38971.70	0.3086	612.1	117.7	6366.9	525.66	2.0553
1996	32152.30	13568.10	45720.40	0.2968	662.9	108.3	6897.0	563.53	2.1347
1997	34854.60	13155.60	48010.20	0.2740	681.4	102.8	7045.8	569.93	2.1885
1998	36921.10	12881.70	49802.80	0.2587	676.0	99.2	7367.3	590.28	2.2374
1999	39334.40	14571.10	53905.50	0.2703	666.5	98.6	8087.4	642.32	2.3342
2000	42911.90	13218.60	56130.50	0.2355	669.2	100.4	8387.7	662.62	2.4556

Notes: Population in 10,000 persons
Household income, saving, consumption in 100 million current RMB Yuan
Real income in 100 million constant 1950 RMB Yuan
E/M = Number of persons employed / Number of persons 14 years and younger.

there were no significant personal income taxes prior to the recent decade. Our saving ratio is, in effect, the ratio of estimated accumulation of assets to the sum of consumption and accumulation.

Table 1 shows that the household saving ratio was quite low in the pre-reform period 1953–78. The very low saving rate from 1962 to 1964, negative in the first year, was the result of severe natural disasters in three consecutive years and can be regarded as a transitory phenomenon. But even without these three years, the saving ratio from 1953 to 1978 averaged less than 5 percent. All in all, it is apparent that there was not much household accumulation during this time. Furthermore, the saving rate did not exhibit any clear positive trend even though the real per-capita income increased by 60 percent (see table 1 and figure 1). It is noteworthy that the growth rate was quite modest during these 25 years. It averaged less than 5 percent annually. In the 22 years subsequent to the economic reforms, the estimated saving ratio has increased consistently from 5 percent in 1978 to an incredible peak of 34 percent in 1994, and still attained the 24-percent level in 2000!

It is worth noting that our data does not include pension distribution or investment in financial securities other than government bonds. We were not aware of reliable time series pension data at the first writing. Investment in equity securities and mutual funds did not become significant until recent years. However, the slower growth in currency in circulation and deposits in 1999 and 2000 is certainly related in part to the flow of money into the equity market in those years (89 billion yuan in 1999 and 102.4 billion yuan in 2000). The pension system in China has been largely a fragmented pay-as-you-go system operated by individual companies, though the government since the mid-1980s has initiated experiments to pool pension assets and put them under control of local or provincial governments. The pooling effort has brought more credibility to the system. One can infer from the rapid growth in pension distribution in the 1990s (see table 2) that this would have had a negative impact on people's incentive to save for old age.[3]

3. *Alternative Models of Saving Behavior*

3.1 *The Standard Keynesian Model and Its Rationale*

In the standard Keynesian model, saving is supposed to depend entirely on current income. Furthermore, the saving-to-income ratio is expected to be an increasing function of income. That is, the national saving ratio would rise as per-capita income rises within a country or between countries. Accordingly, the saving function is typically approximated by a linear form:

$$S = s_0 + sY \qquad (1)$$

implying (1') $S/Y = s + s_0/Y$, $s_0<0$.

It is generally believed that this model can be used to explain the saving behavior of the relatively poor countries. The reasoning follows that people with low incomes may not be able to afford the sufficient level of saving when they are young and productive to support their consumption in old age, or at least not as much as people with higher incomes. The ability to make intertemporal transfers of resources constitutes the very foundation of the life-cycle hypothesis (LCH). Even if one accepted this reasoning, the line, if any, that separates the rich from the poor could only be established empirically. In our view, the relevance of LCH for a country depends on the existence of a sufficiently large core of households that are able to carry over

[3] As Modigliani and Sterling (1983) show, pension contribution does not automatically decrease household saving, in part due to early retirement induced by the existence of a pension program. Our casual observation indicates the latter effect was not apparent in recent Chinese history, which leads us to conclude the evolvement of the pension system in China had a negative impact on household savings.

TABLE 2
PENSION DEVELOPMENT IN CHINA: 1989–2000

	Number of Employees Contributing to Pension million	Number of Retirees Contributing to Pension million	Pension Contribution billion Yuan	Pension Distribution billion Yuan
1989	48.2	8.9	14.7	11.9
1990	52.0	9.7	17.9	14.9
1991	56.5	10.9	21.6	17.3
1992	77.7	16.8	36.6	32.2
1993	80.1	18.4	50.4	47.1
1994	84.9	20.8	70.7	66.1
1995	87.4	22.4	95.0	84.8
1996	87.6	23.6	117.2	103.2
1997	86.7	25.3	133.8	125.1
1998	84.8	27.2	145.9	151.2
1999	95.0	29.8	196.5	192.5
2000	104.5	31.7	227.8	211.5

resources to provide for old age at a standard of living commensurate with that of preretirement. We hypothesize that China might well qualify, especially in view of two circumstances. The first is the absence of a national public pension system (social security) and scarcity of other pension institutions until the most recent decade.[4] The second, discussed below, is that, traditionally, the source of old-age support in past generations was children. This tradition was severely curtailed by the policy initiated in the 1970s to limit the number of children to one per family.

3.2 *The Life-Cycle Hypothesis (LCH) Model and Its Implications for Steady Growth*

The fundamental and novel implication of the LCH is that the national saving rate, *S/Y*, is unrelated to per-capita income but depends instead on the long-term rate of income growth. This result has been demonstrated in numerous earlier papers, including, in particular, Modigliani's Nobel lecture (Modigliani 1989). A short summary of the earlier demonstrations will be sufficient.

The model starts from the classic Fisherian postulate that individuals choose to maximize utility derived from their life resources by allocating them optimally

[4] The national pension system started to take shape in the 1990s. According to China's Ministry of Labor and Social Security, the system covered 104 million employees and 32 million retirees at the end of 2000. The contribution to the fund was 228 billion, compared to our personal savings estimate of 1322 billion. In addition, 62 million rural residents participated in the government-sponsored rural pension plan (see table 2).

between current and future consumption. Accordingly, it identifies life resources, instead of current income, as the budget constraint. This postulate, when combined with the assumptions: 1) stable preferences for the allocation of resources over a finite life are independent of the size of life income, and 2) a stable path of resources by age will give rise to a stable age pattern of the saving-to-income and wealth-to-income ratio. Now, suppose aggregate income grows in time at a constant percentage, say *g*. Consider first the case when the growth is due entirely to population growing at that rate, while per-capita income remains constant. Then, as time goes by, each age group, as well as aggregate consumption and income, all rise at the rate *g*, but the consumption-to-income, saving-income, and wealth-to-income ratios are constant. Thus, for any given *g*, the national wealth is proportional to income or $W = wY$, where w is a constant that is independent of income (though, possibly dependent on *g*). Since saving is the growth of wealth, we can infer:

$$S/Y = \Delta W / Y \equiv w\, \Delta Y/Y \equiv w\, g$$

where $g = \Delta Y/Y$, the income growth rate—that is, the saving ratio is independent of income. Instead, it is related to the income growth rate. If the growth rate is stable, say *g*, then *S/Y* should be a constant, *wg*. In particular, if income were stationary, so would wealth be, and saving would be zero, regardless of per-capita income. Similar conclusions hold when growth is the result of growing productivity (per-capita income). Furthermore, the relation between saving and growth does not seem to be affected much by the source of growth. That is, the value of *w*, for a given *g*, does not seem to be very different, whether *g* is due to a steady population growth, or productivity growth, or some mixture of the two.[5]

[5] Modigliani (1970) discussed in detail the identification problem, i.e. the interaction between saving, investment, and the growth rate.

We can conclude that, as long as income is growing fairly steadily, the saving function implied by the LCH can be written as:

$$S/Y = s'_0 + s'\, g + e \qquad (2)$$

where s'_0 should be close to zero, s' should be significantly positive and e is a random error term (iid).

An alternative way of arriving at the above result is to recognize that the assumptions stated earlier about the path of consumption and income imply that aggregate saving is a linear (homogenous) function of income and wealth. One can readily show that this equation implies that if income is rising at a constant rate, the saving wealth-income ratio will tend (asymptotically) to a constant, and therefore *S/Y* will tend to satisfy equation (1).

3.3 *The LCH Consumption Function When the Economy Is Not in Steady Growth*

3.3.1 *Demographic Growth vs Demographic Structure*

As was pointed out in Modigliani (1970), according to LCH, the saving rate increases with a steady population growth. But the relation is not a directly causal one. What truly affects the saving rate is demographic structure. In particular, the relation between the working and nonworking populations is the most important factor because the latter group tends to reduce national household saving, since it consumes without producing an income. The nonworking population includes the retired and those too young for regular employment. The latter will be referred to as the "minors" in this paper. Demographic structure is predictably related to population growth if, and only if, growth has been stable for a period long enough so that the structure has reached an equilibrium point for that growth.

When population growth has been varying over periods of time, the number of people in the different age cohorts grows at different rates. Then, the current growth rate will have no systematic correlation with the

demographic structure and the saving ratio. These considerations are clearly relevant in China's case due to the wide swings in birth rates and age-specific mortality rates during the past half century. In these circumstances, Modigliani (1970) argued that population growth should be replaced by direct measures of demographic structure such as those mentioned above. He showed, on the basis of a large cross-section of countries, that both the ratio of retired population (age 65 and over) and of preworking population to the working-age population (20 to 65) had a strong and highly significant negative effect on the saving ratio. For China, there are a number of considerations, supported by some preliminary explorations, that have led us to conclude that the crucial demographic variable is the relation between the employed population and the number of minors, denoted hereafter as *E/M*. The typical age at which a person is classified as an adult is different from country to country. It tends to rise with the degree of development. For China in its early development stage, we concluded that people could be classified as minors up to the age of fifteen.

We wish to stress that the variable, *E/M*, has special relevance for China during the period we are studying because of its relation to a culture-related variable, the birth rate, which was greatly influenced by government policies. In the Chinese cultural tradition, the younger generation is supposed to take care of the elder members of the family, while the elders will bequeath the house and other assets to their children. In other words, an economic unit is the extended family rather than the nuclear family. Under such a system, a child is an effective substitute for life-cycle saving. Consequently, when strict birth-control measures came into effect in the 1970s, the accumulation of life-cycle (tangible) assets gained in importance as a substitute for children. One may also argue that even if the Chinese birth-control policy did not occur, the secular trends of 1) more nuclear families; 2) migration of families from their ancestral homes; and 3) less loyalty to elders would have had the effect of reducing the role of children as a substitute for saving, anyway.

Unfortunately, official information on minors is only available for a few selected years (1953, 1964, 1982, 1990, and 2000). However, as expected, it correlates well with the number of births recorded over the previous fifteen years. Accordingly, we have used this data series, available annually, to interpolate between the years for which we have official information.[6] The birth rate is shown in figure 2. *E/M* and *S/Y* are shown in figure 3. *E/M* reflects the effectiveness of the birth-control policy and economic expansion. It is relatively flat until the mid-70s, and then increases appreciably and steadily for about fifteen years until the end of the 1980s. It is apparent that *S/Y* follows the trend of *E/M*. The closeness of the two curves, confirmed by a simple correlation of 0.95, suggests that the close fit reflects not only the usual impact of *E/M* on the saving ratio (through the "less mouths to feed" effects) but also, in particular, the impact of the birth-control policy on the incentive to accumulate wealth for old age. The close correlation of the two series weakens after 1994 as *S/Y* starts to decline, while *E/M* continues to rise.

3.3.2 *Modeling Permanent Variation in the Per-Capita Income Growth Rate*

With respect to the productivity growth component, the basic hypothesis is stated in (2). But there is a problem in that (2) has been shown to be an implication of the LCH in the presence of a lasting and stable income growth trend. Now it is obvious that in China the growth rate has been far from stable. Until the mid-70s, it averaged around 2 percent. It then rose almost monotonically, reaching over 10 percent in the early 90s and falling again in the late 90s. One possible

[6] Liao Min contributed to the development of this approach.

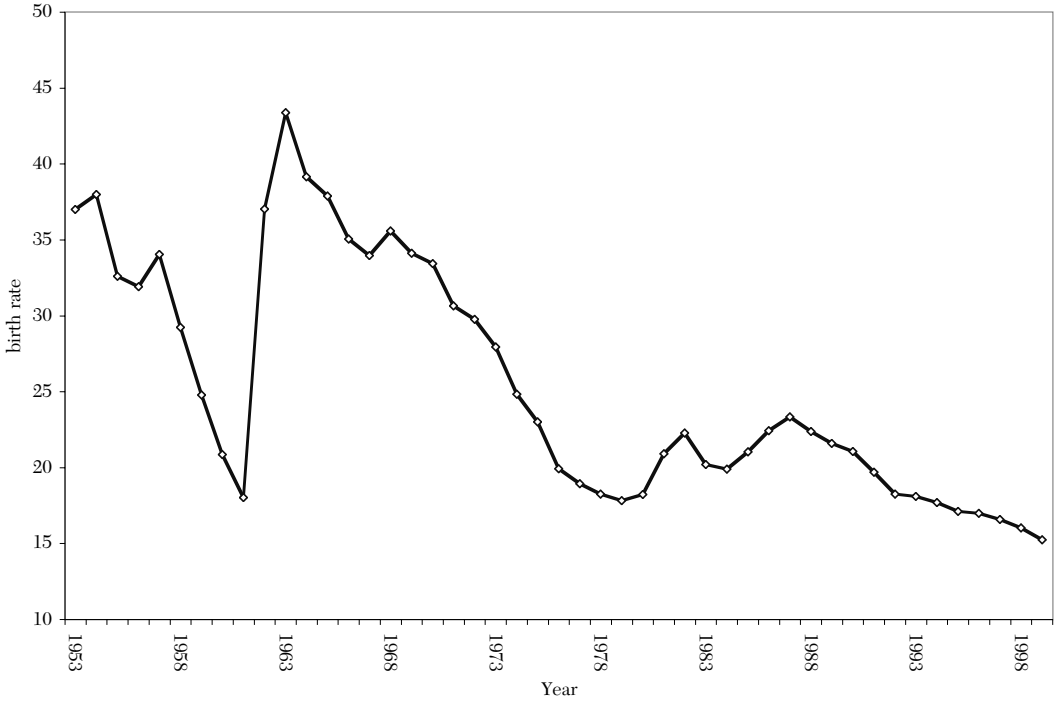

Figure 2: China's Birth Rate Per Thousand Persons: 1953–99

first approximation can be obtained by measuring the growth trend not by the current or recent growth (which would be quite erratic), but by the average annual growth over an extended period of past years. In principle the period should be long, subject to the availability of data. In the case of China the data are an important limitation, as our estimates of disposable income growth begin only in 1953 and end in 2000. We have 48 years of data. Using a really long period would result in losing a large portion of our sample. We have settled for a compromise by measuring the growth trend for every year and by using the average annual rate of growth over the previous fourteen years (year one through year fifteen). This procedure results in the loss of the first fifteen observations, leaving us with a sample of 34 observations (1966–2000). However, many of the results presented below have been obtained using the entire sample, and approximating the growth trend of the missing previous fourteen years by the average annual growth rate for all the years available, up to the given year. This procedure yields a sample of 43 observations (1957–2000). This approximation is "courageous," but the early years are important because they are quite different from the later ones, and we submit that the approach is unlikely to cause serious bias since, in the early years, the growth is relatively constant and quite small.

The saving ratio and the per-capita income growth trend are shown in figure 4. The per-capita real income curve tracks remarkably closely with the wide fluctuations of *S/Y* from its trough in the 60s to its peak in the mid-90s. At the end, the *S/Y* decelerates faster than the growth trend. This difference will be explained below. On the whole, the graph provides surprisingly strong support

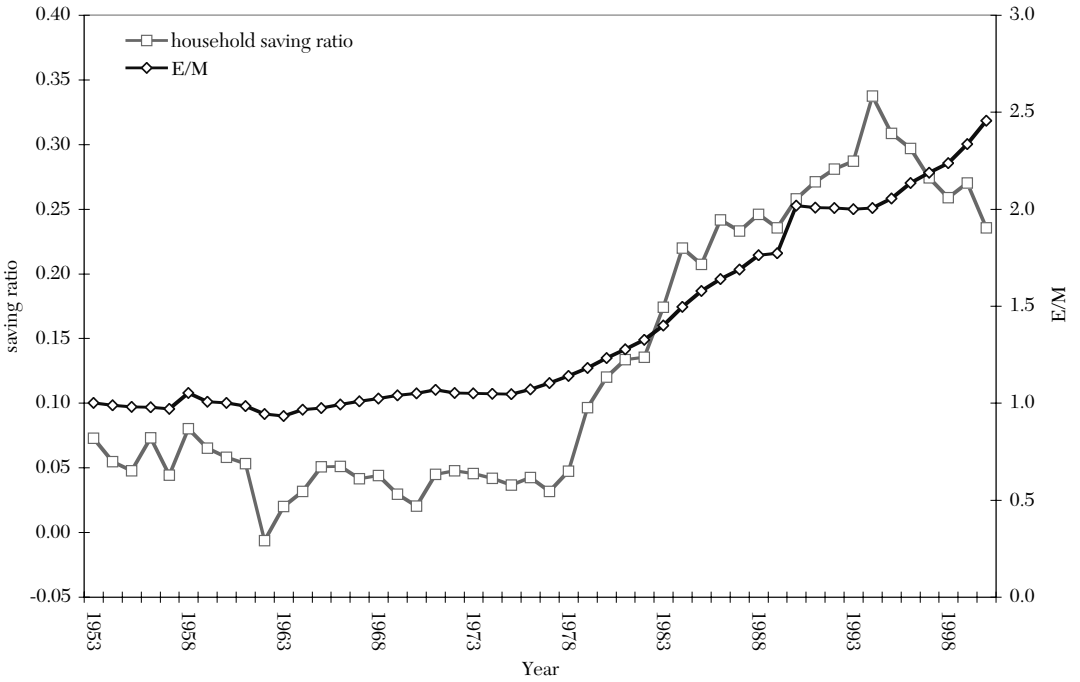

Figure 3: Saving Ratio and E/M

for the LCH hypothesis as an explanation of Chinese saving.

The fifteen-year average growth rate is the basic variable used to estimate the growth effect. We will provide some refinements of this measure, which takes into account the possibility of differential effect for the more recent growth rates.

3.4 *The Role of Inflation*

3.4.1 *Impact of Inflation on Measurement of Income and Saving*

The presence of price variation (inflation) over the time period poses a number of measurement problems. First, in the presence of significant inflation, one must distinguish between current (nominal) and real values. The later are conceptually measured in constant prices. In this study, we rely systematically on real values (i.e., measured in constant prices, estimated by deflating nominal values by an overall consumer price index, CPI1950 = 100.

Inflation poses another problem that is generally neglected. Basically the problem arises from the fact that saving is the difference between income and consumption. Consumption is well defined, but income, and the corresponding saving, may take on a number of different definitions. These different measures all coincide in the absence of inflation, but differ, possibly quite substantially, in the presence of significant inflation. Furthermore, these different measures respond differently to inflation. The alternative measures are described briefly below:

1. S(1), the national income accounts (NIA) definition of personal saving as the difference between net-of-tax personal income, Y, and consumption, C, or $S(1)=Y-C$.
2. S(2), the value of the net acquisition of

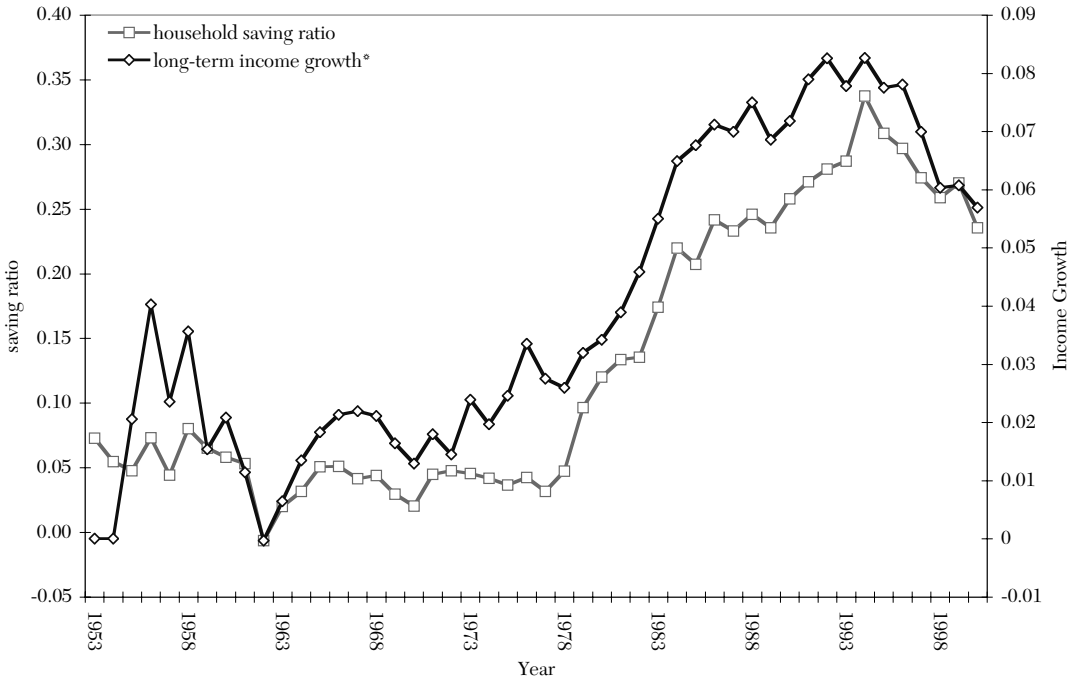

Figure 4: Saving Ratio and Long-Term Income Growth

personal assets during the period. This measure is conceptually identical to the first: i.e., S(2) = DA = Y–C = S(1). However, the statistical measure may differ because of error of measurement.

3. S(3), the personal sector contribution to the financing of national investment. In the absence of inflation this measure coincides with S(1) and S(2) above, and this is the basic reason why these measures are of special interest. But this coincidence ceases in the presence of inflation. With inflation, there are two distinct measures of the interest rate and two corresponding measures of income and saving. One is the conventional "nominal" rate, R, which measures the amount of money obtainable next period per unit of money delivered now. The other is the Fisherian "real rate," r, which measures the amount of "commodity baskets" next period per basket now. It can be derived from the current rate, by subtracting from it the rate of inflation, p, over the term of the loan contract, or $r=R–p$. In a perfectly rational market economy, with only short-term loans, inflation would have no effect on the real rate r (the classic neutrality of money), and therefore would raise the nominal rate by p, so that $R = (r + p)$. Actual experience suggests that R will in fact rise in response to inflation, but possibly less than one for one, at least initially, so that $R(p)$ can be written as $R = r+ zp$, where z is between 0 and 1. That means that inflation causes conventionally measured income to rise by the increase in R, zp, times the amount of personal net wealth invested in nominally fixed assets, say A^*. However, it must be remembered that all nominal claims of the private sector on the private sector

are offset by a corresponding debt, which results in increasing the wealth of the debtor. Thus, the private sector's net nominal wealth turns out to be essentially the interest-bearing portion of the government debt.

If we subtract from Y the inflation effect, zpA^*, we obtain an inflation-adjusted measure of income, $Y(3) = Y–zpA^*$. We suggest that, with inflation, the relevant measure of saving should be "adjusted" income minus consumption:

$$S(3) = Y(3)–C = S – zpA$$

as this provides a better approximation than the conventional S(1) as a measure of the contribution of the personal sector to national capital formation. The reason is that, though the actual conventional saving is S or $S(3)+zpA$, the zpA component does not add to national saving because it is offset by an equal rise in the outlays (and deficit) of the government, reflecting a rise in the nominal interest paid by the government due to inflation.

4. S(4), the net increase in the purchasing power of the stock of assets owned. This differs from and exceeds S(2), or DA, the nominal value of net assets acquired during the period, insofar as the wealth carried over from the previous period contains any "nominal" assets, A. These assets will lose purchasing power between the beginning and end of the current period, through the erosion due to inflation. The loss of purchasing power of assets outstanding at the beginning of period t can be written as $[p(t)\ A^*(t–1)]$, where $p(t)$ is inflation in period t. Hence to compute S(4) we subtract this quantity from the acquisition of assets, or:

$$S(4) = DA – p(t)\ A^*(t–1) = S(1) – pA^*(t–1) \qquad (3)$$

Another useful way to understand the meaning of S(4) is to think of it as the result of subtracting consumption from NIA disposable income, properly corrected for the loss of purchasing power due to inflation. That corrected measure is $Y^*(t) = Y(t) – p(t)\ A^*(t–1)$. Subtracting C from Y^* yields $S^*(t) = S(t) – p(t)\ A^*(t–1)$.

Note that Y^* and S^* are the measures that would result if one computed the interest income from nominal assets using not the nominal rate, R, which is standard procedure, but the Fisherian "real rate" $(r – p)$. It is apparent that, in the presence of inflation, the conventional NIA measure of saving is an upward-biased measure of the increase in personal wealth.

3.4.2 *The Impact of Inflation on Saving Behavior*

Inflation can also affect saving behavior through a variety of channels, including deviations from rational behavior which result from difficulties of understanding its real implications. Let us consider first whether and how inflation might be expected to affect the conventional measure $S(1)/Y$, henceforth referred to as S/Y. It turns out that the answer to this question is more readily understood by looking at the ratio $C/Y = 1 – S/Y$. To understand the response of C/Y we must ask what will inflation's expected impact be on the numerator and the denominator. The denominator is affected, since, as we have argued above, the NIA measure of income Y is $Y(3) + zpA^*$. Here $Y(3)$ is supposedly broadly invariant with respect to inflation, z, is the impact of inflation $p(t)$ on the nominal interest $R = r + zp$, and could be anywhere between 0 (complete inflation illusion) and 1 (Fisher's law), in an economy with perfect markets, perfect foresight, and rational behavior. Hence, inflation has the effect of adding zpA^* to NIA income Y.

For consumption, the response should be the marginal propensity to consume, c, times the increase in income as perceived by the consumers, let us call it Y^{**}. This quantity will differ from Y because it may take into account, at least partially, the loss of purchasing power due to inflation. We may assume

that the perceived loss is proportional to the actual loss, and can be expressed as $hp(t)A^*(t)$, where h should again fall between 0 (total inflation illusion by the personal sector) and 1 (no inflation illusion, so that the perceived loss coincides with the actual loss). So the effect of inflation on C, (dC/dp), can be expressed as $cA^*[z - h]$. With the help of these results, one can readily establish that the effect of inflation on the consumption ratio reduces to

$$\text{d/dp (C/Y)} = \text{k A/Y} \qquad (4)$$

where $k=[(c–C/Y)\, z - ch] = –d/dp(\text{S/Y})$ and k measures the effect of inflation on the consumption ratio ($–k$ the effect on the saving ratio) per point of inflation. Since A, Y, and p are all directly measured, (4) tells us that we can estimate k as the coefficient obtained by adding $p(A/Y)$ to the list of variables supposed to explain S/Y.

Our theory implies some definite bounds on the value of k. Since the marginal propensity to consume can be counted on to be smaller than the average, our theory implies that $k<0$, i.e., that inflation must have a positive effect on the NIA saving ratio (except in the limiting case, when $z=h=0$ or universal, 100 percent inflation illusion.) It can also be seen that (4) is a decreasing function of both z and h. Therefore $–k$ (the effect on S/Y) should not exceed C/Y, the average propensity to consume, that for China could be placed, on average, at around 0.8.

One can similarly establish that (see section 5.2.3)

$$\text{d/dp [C/Y(3)]} = \text{k(3) A/Y} \qquad (5)$$

where $k(3) = c(z\text{-}h)$.

As indicated earlier, (5) yields what we regard as the most relevant measure of the effect of inflation on the supply of resources for capital formation—namely the negative of the effect of inflation on consumption. In the absence of inflation illusion, z and h are unity, and as expected, the effect is zero inflation has no real effects. In general the effect depends on the relative size of z and h. This is an empirical question and, most likely, it depends on the size and duration of the inflationary process, presumably approaching one and neutrality as the process continues.

Finally, one finds

$$\text{d/dp [C/Y(4)]} = \text{k(4) A/Y} \qquad (6)$$

where $k(4) = k + C/Y>0$, so that, as one might expect, inflation reduces saving defined as the net accumulation of real personal assets (because it fails to reduce consumption by as much as the loss of purchasing power of the initial nominal assets.).

4. *Estimation*

From the graphs presented earlier, it is apparent that the saving ratio, long-run growth, and the population are drifting together. This suggests that they can be co-integrated. To establish co-integration we must first check whether each series is integrated and contains a unit root. The results of the augmented Dickey-Fuller with one lag and a constant in the test equation are presented below:

	S/Y	ΔS/Y	g
ADF t-stat	–4.0***	–0.47	–0.55
	Δg	M/E	ΔE/M
ADF t-stat	–3.3**	2.75	–2.75*

***:1 percent, **:5 percent, *:10 percent MacKinnon critical values for rejection of hypothesis of a unit root.

The tests indicate that the three series contain a unit root. Given that each series has a unit root, we now test whether the series are co-integrated over the sample period and if so, what the co-integrating relationship is. To test co-integration we use two methods, the first being the Engle and Granger (1987) two-step method. The first stage consists of regressing the variables supposed to be co-integrated. The second stage consists of testing for a unit root in the residuals. Since the residuals are estimates of the disturbance term, the asymptotic distribution of the tests

TABLE 3
ESTIMATES OF COEFFICIENTS OF SAVING FUNCTION

Coefficient	Variable	Coefficient	Variable
a_0	constant term	a_3	growth from previous year minus long-term growth
a_1	long-term growth (15 years)	a_4	inflation
a_2	E/M: dependency ratio	a_5	reciprocal of per-capita real income

Equation Number	Original #	Method	I. 1953–2000 (all years) a_0	a_1	a_2	a_3	a_4	a_5	ADF t-stat	N
I.1	1	OLS	-0.03	4.03					-2.87	1.00
R^2=0.93	t-value		-4.39	25.79						
I.2	2	OLS	-0.16		0.21				-1.71	1.00
R^2=0.889692	t-value		-9.96		19.26					
I.3	3	OLS	-0.10	2.57	0.09				-3.12	2.00
R^2=0.972540	t-value		-9.66	11.47	7.36					
I.4	4	OLS	-0.10	2.07	0.10	0.10	0.26		-2.83	2.00
R^2=0.98	t-value		-11.0	8.85	9.04	2.08	3.78			
I.5	5a	OLS	0.31					-0.25	-2.11	1.00
R^2=0.85	t-value		24.4					-15.9		
I.6	6	OLS	-0.12	2.16	0.11	0.10	0.26	0.01		
R^2=0.98	t-value		-3.50	7.85	7.33	2.15	3.69	0.65		

Equation Number	Original #	Method	II. 1953–1985 a_0	a_1	a_2	a_3	a_4	a_5	ADF t-stat	Critical value
II.1	10a		-0.01	3.18					-2.87	1.00
R^2=0.85	t-value	-	-2.1	12.8						
II.2	20	OLS	-0.26		0.30				-2.38	1.00
R^2=0.845	t-value		-10.3		13.1					
II.3	40	OLS	-0.13	1.52	0.14	0.14	0.74		-2.18	2.00
R^2=0.92	t-value		-3.23	3.50	3.04	1.95	1.79			

Equation Number	Original #	Method	III. 1978–2000 a_0	a_1	a_2	a_3	a_4	a_5	ADF t-stat	Critical value
III.1	10a		-0.03	4.00					-2.91	1.00
R^2=0.88	t-value	-	-4.00	25.00						
III.2	20	OLS	-0.06		0.16				-0.68	1.00
R^2=0.71	t-value		-1.43		7.26					
III.3	40	OLS	-0.10	2.52	0.09	0.13	0.18		-3.97	2.00
R^2=0.97	t-value		-6.22	8.80	7.90	2.23	2.81			

Critical values — N: number of I(1) series for which the null of non-cointegration is being tested.

N=1	1%	-3.577736295	N=2	1%	-4.247013043	N=3	1%	-4.619791871
	5%	-2.925594329		5%	-3.463602079		5%	-3.930802647
	10%	-2.600478072		10%	-3.134931947		10%	-3.586992439

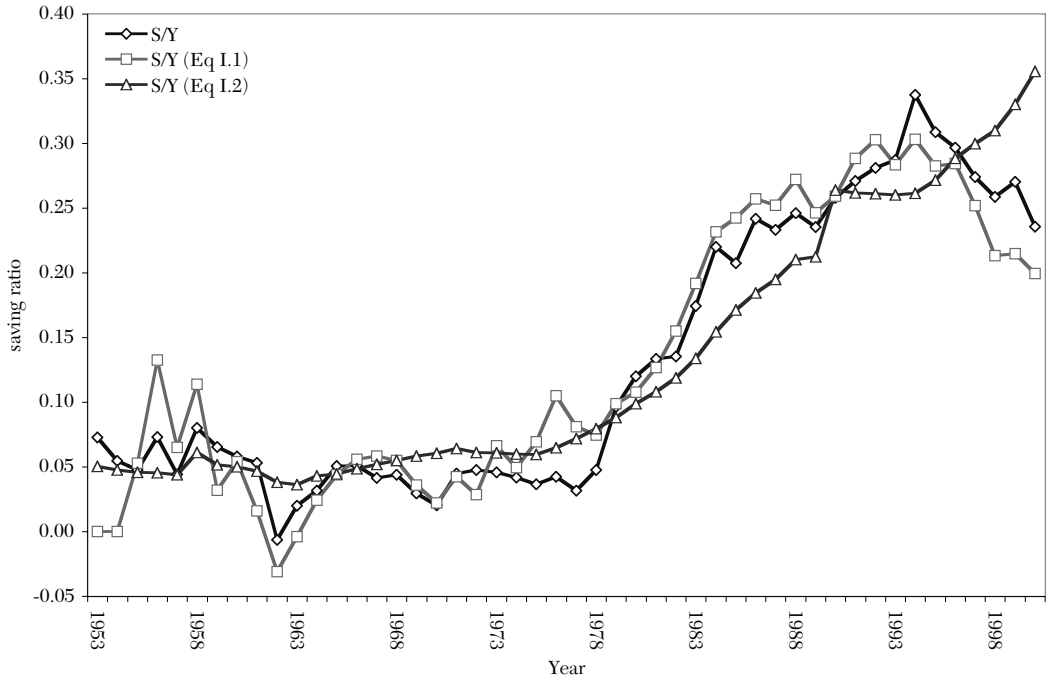

Figure 5: Saving Ratio, Long-Term Growth and Ratio of Employment to Minors

statistic differs from the one for ordinary series. (The correct critical values are obtained from Russell Davidson and James MacKinnon 1993, table 20.2).

Table 3 reports the results of the estimation (see also figure 5). The first row of each equation contains the estimated coefficients. The second row shows the corresponding t-values. The first two equations (I.1 and I.2) are the regressions on the saving ratio on the long-term growth rate and the E/M ratio, respectively. The last two columns report, respectively, the ADF-t statistic of the regression residuals and the critical value. The first variable is the estimated growth trend, measure by the average rate of growth over the fifteen preceding years. The R_2 is 0.93, and t-value is 26, confirming the amazingly high explanatory power of this crucial LCH variable. The only qualm raised by this result is the coefficient of the growth variable; the value of 4 is a bit high, certainly higher than that obtained in earlier studies (see below) which typically runs around 2 or not much higher. But this anomaly will be shown to be, most likely, the "spurious" result of high correlation with the other major explanatory variable, population structure, E/M, whose coefficient is reported in equation I.2. This variable too fits the saving pattern remarkably well as demonstrated by an R_2 of nearly 0.9 and a t-value of 19. The regression coefficient, 0.21, is again on the high side compared with other studies but for the same reason.

The conjecture about the upward bias in the slope estimates of the previous two equations is confirmed by the results reported in equation I.3, where the two variables are introduced simultaneously. Both coefficients come down to reasonable levels while remaining highly significant.

In the remaining equations of part I we have tested a number of refinements to the basic model. First one can see from figure 1 that the growth of *S/Y* is not smooth but instead is

interrupted by several "bumps" that represent short-term, transitory deviations from the long-term trend. According to LCH or the permanent income hypothesis, the propensity to save during such transients should be exceptionally high. We have introduced a new variable, the deviation of each year's growth from the long-term growth rate, as a rough but simple way of measuring the transient component. The coefficient of this variable reported in the a_3 (table 3) column has the expected positive sign and is moderately significant.

There remains to be tested the impact of inflation on the saving ratio. That impact, we recall, depends on the definition of income and saving. In the table the definition of the saving ratio is that adopted by the NIA or S/Y. The estimated coefficient is reported in the column a_4. Inflation is measured by the quantity pA^*/Y; therefore what is being estimated is the parameter k of equation 4, in section 3.4.2. From the analysis developed there we have concluded that according to our model the parameter $-k$, measuring the impact of inflation on S/Y, could be expected to be decidedly positive but appreciably less than 0.8. The estimate under a_4 is 0.26, which falls clearly within the stated limits and is highly significant with a t-value over 3.

Equations I.5 and I.6 present one last test focusing on a comparison of the relevance of the LCH versus the standard linear Keynesian model in accounting for the Chinese experience of the last fifty years. Equation I.5 gives the results of fitting the S/Y data to equation 1; according to which, S/Y is a linear function of the reciprocal of Y. Its coefficient, given in the column a_5, corresponds to the constant term of the linear equation. It is significantly negative, but this is not surprising since the accelerating pattern of income, which resulted in a rising saving rate, also resulted in a sharp rise in income. On the whole, S/Y and Y moved together. But the Keynesian equation is completely incapable of accounting for the initial stagnant period when S was flat though Y was rising moderately, or the sharp acceleration beginning in the late 1970s, or the decline after 1993. Equation I.6 consists of adding the Keynesian variable $1/Y$ to the (significant) variables of the LCH in equation I.4. The coefficient of this variable, reported in the column a_5, has become insignificant and has the wrong sign. We must conclude that there is no evidence whatsoever to support the conventional Keynesian hypothesis.

The final hypothesis, represented by equation I.4, is seen to account closely for the highly unusual behavior of the Chinese saving ratio in recent decades. This can be inferred from the R_2 of 0.98. This value is strikingly high when one remembers that we are correlating dimensionless variables such as population structure, income growth rate, and inflation rate to the saving ratio. The closeness of fit can be judged from figure 6, which compares the actual pattern of the NIA saving ratio with the value calculated by using the fitted equation (I.4). It is apparent from figure 6 that the pattern of the saving ratio modeled by equation (I.4) follows very closely that of the actual saving ratio.

These results appear strongly supportive of the LCH and inconsistent with the traditional view, and this is confirmed by some tests of the reliability of the estimates, reported in the next two sections.

According to the conventional view, the S/Y ratio is supposed to be quite stable in time, at least for a given country. In the case of China, on the other hand, both actual and computed saving ratios are small—mostly below 5 percent—and relatively stable, from the early 1950s to 1978, a period characterized by modest growth rates (some negative)—except for 1958—very little inflation (some negative), and a low and stable E/M. Beginning in the late 70s with the economic reforms, the short-term and the long-term growth rates accelerate to a peak in 1994. During this same period, the enforcement of the one-child policy leads to a gradual reduction in the ratio of minors to employment, thereby, presumably reducing the consumption-to-income ratio. The net

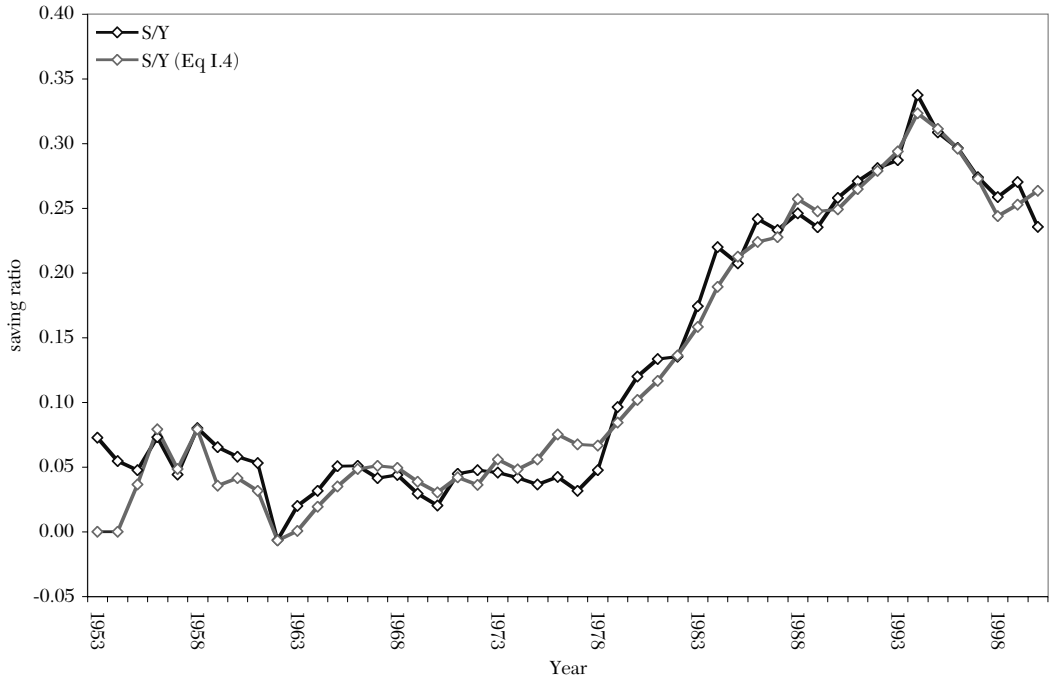

Figure 6: China's Saving Ratio 1953–2000: Actual and Computed Values from Equation I.4

result is increasing the accumulation of marketable wealth. In addition, in the later years the saving-to-income ratio appears to be boosted by a couple of episodes of high inflation—one at the very end of the 1980s, the other even higher in the mid '90s. At the peak of the second inflation period, in 1994, our estimates suggest that it could have contributed as much as 6 percentage points to the peak of the saving ratio of almost 34 percent. After 1994, *S/Y* declines steadily as inflation is brought promptly to an end and growth decelerates steadily. These two variables outweigh the still expansionary effect of *E/M*.

Before endeavoring to draw some conclusions from our LCH Equation I.4, we report some tests of the reliability of our estimates.

5. *Tests*

5.1 *Stability over Time*

For this test, the entire sample is subdivided into two subsamples. The first consists (predominantly) of the years 1953–1985 (33 years). The second period consists of the years 1978–2000 (23 years). Several equations of part I were reestimated for each subsample and selected results are reported in parts II and III of the table. Equations II.1 and III.1 replicate the equation I.1 for each subperiod. The results confirm the crucial role of long-term growth in accounting for the behavior of the saving ratio in each subperiod. This is indicated by very high t-values and by the estimated coefficients, which are reasonably close. A somewhat similar result is found for the other LCH variable, *E/M*, equations II.2 and III.2. Equations II.3 and III.3 show the results of reestimating the full model of equation I.4 for each subperiod. It is seen that the estimated coefficients of the two basic variables, per-capita growth and the demographic ratio measured by *E/M*, are all highly significant and remarkably stable; the variable measuring deviation from the

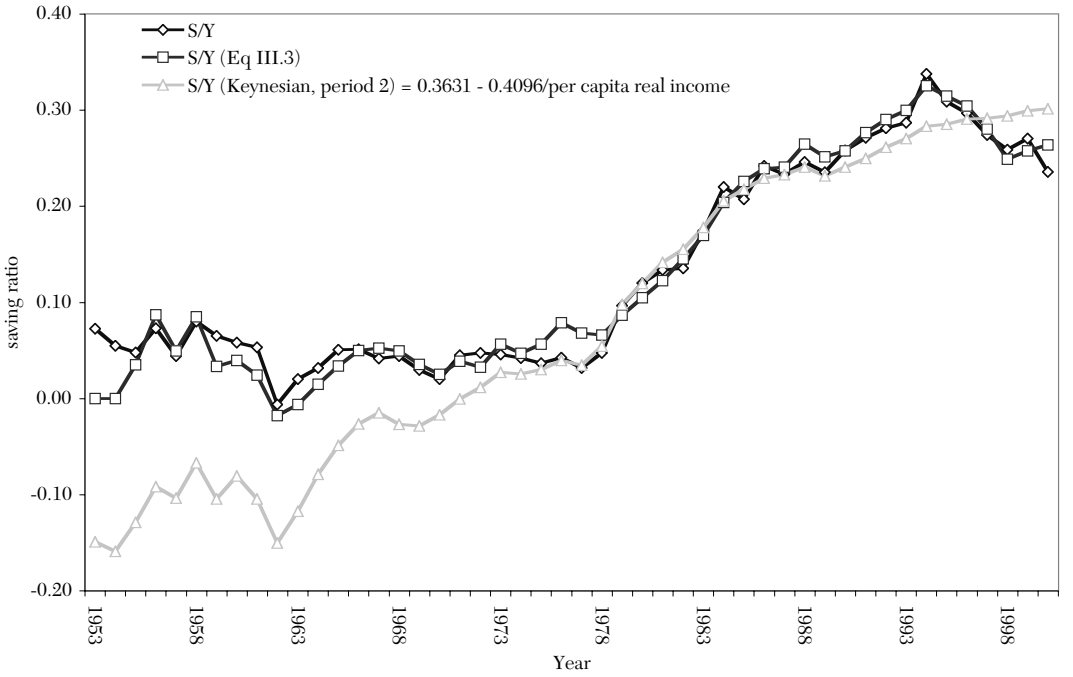

Figure 7: Saving Ratio: Actual and Computed Values from Equation III.3

growth trend is also significant and pretty stable. The remaining coefficient, that of inflation in column a_4, is less stable, being very high and barely significant for the first period.

But, there is a good reason for this event, namely that inflation in China appears to have been very sporadic. In a couple of cases it reached quite high levels, but those episodes occurred entirely in the second of our two periods (one in 1987–89; the second, more serious one in 1993–95). But from 1953 to 1985, prices were remarkably stable, at least as measured by the official consumer price index. Under these conditions we lack the information needed for a reliable estimate. And this lack of reliability is confirmed by the fact that the coefficient of 0.74 reported in equation III.3, col. a_4, is estimated with margin of error, as evidenced by a standard error of 0.4.

We have devised a test, however, to verify the validity of this explanation. If the coefficients of the first and second periods are basically the same up to statistical sampling error, then the second-period equation, which is "well estimated," should provide a good explanation for the behavior of *S/Y* in the first period. Our test then consists of using the parameter estimates for the second period to obtain "computed" values of *S/Y* for the first period. If our hypothesis is valid, we should find that these computed values fit well the first-period observed values. The results of this test are presented in figure 7. The curve marked with diamonds at the top of the graph is once again the observed saving rate. The curve that hugs it closely is the saving ratio computed from the second period equation, III.3, that is fitted to data from 1978 to 2000. It is apparent that these computed values fit the actual out-of-sample data from 1953 to 1978 remarkably well, with moderate underestimation in 1962 to 1964.

On the basis of this result it seems justified to conclude that the LCH model

applies to the entire period with reasonably stable parameter estimates, despite the very notable changes in the underlying economy.

The third curve shown in figure 7 is an analogous test of stability of coefficients for the traditional Keynesian linear model. That is, we fit this model to the years 1978–2000, and find that this fit is bearably good though it misses the later decline. When we use the parameter estimates from the second period to compute the first period saving ratio, the result is a total failure; if saving were controlled by income the rise would have been much faster and there would have been a lot of "dis-saving" with the very low initial income. But the observed behavior is accounted for when Keynesian income is replaced by LCH variables, income growth, and population structure.

5.2 *Comparison with Earlier Studies—A Survey*

There are two major studies of which we are aware that have endeavored to test the LCH and estimate its parameters. First, Modigliani (1970) used a sample of 36 countries for which data were available from the UN Yearbook of National Account Statistics to test whether cross-country variations in the saving ratio could be accounted for by differences in growth rates and demographic structure, as hypothesized by LCH, instead of by differences in per-capita income according to the traditional view. This sample, which includes countries of quite varied backgrounds, is referred to hereafter as Cross I.

The second essay is Modigliani (1990) (hereafter Cross II), which used a sample of 21 OECD countries for a cross-country test of the forces accounting for the remarkable decline in the average saving ratio from 17 percent in the period 1960–70 to 10 percent in 1981–87, and it included inflation among the explanatory variables. The major conclusions from a comparison of the present study with the previous two are summarized as follows.

5.2.1 *Long-Term Growth*

This crucial LCH variable is found to play a major explanatory role in every case, with t-values running as high as eight (eleven in this study). As for the magnitude of the effect, the estimates for China, of around 2 percentage points increase in *S/Y* per 1-percent long-term growth, or a bit larger for the second period, agree quite well with those of Cross I—a little below two when growth is approximated by productivity, and somewhat lower (around 1.3) when growth is in per-capita income. Cross I, however, measured over a period appreciably shorter, mostly six to ten years, and we know from the Chinese data that shortening tends to attenuate the coefficient.

In Cross II the best measure of growth is found to be quite similar to ours (growth in the previous decade) and the estimates of the coefficient for the private saving ratio are clustered around 2. Cross II also reports the results from a sample of 81 developing countries assembled by the International Monetary Fund. The information for each country is rather limited in terms of the number of observations (1982–88) and quantity, but it includes estimates of the national saving ratio and average rate of growth of income over the six years. One finds that income growth plays a significant role for the sample as a whole and various subsamples. The t-values generally run between 4 and 6.5, and the coefficient estimates between 1.3 and 2.

We can conclude that there is substantial support and agreement among the studies about the central role of income growth and its quantitative impact. The Chinese results also provide a solid confirmation of the finding of Cross I that, contrary to the traditional wisdom, per-capita income is not a significant determinant of the saving ratio. Some evidence to the contrary in Cross I is shown to be the spurious result of cluster effects. However, there is one respect in which the results of Cross II seem to be at

odds with those for China. Analysis of Cross I data confirmed the irrelevance of traditional Keynesian per-capita income for relatively high-income countries, but found some support for that variable for the poorer countries (t-value of 3). That result is not necessarily inconsistent with LCH, since it was initially advanced for developed countries, but is inconsistent with the results for China, which through most of the period was among the world's poorest countries. This discrepancy is one puzzle that remains to be solved.

5.2.2 *Demographic Structure*

For China the "dependency ratio" plays a major role, with t-value up to 9. The coefficient estimate is remarkably stable at 0.1. Both the minor-dependency ratio and the retiree-dependency ratio were also very significant in the studies cited above (see for example *R/W* and *M/W* in Modigliani 1970, table 2).

5.2.3 *Inflation*

There remains to consider the role of inflation that was estimated only for Cross II. There, the estimated effect was consistently negative though moderately significant (highest t-value of 4½) with coefficients indicating a decline of between -0.5 and -0.7 percentage points in the saving ratio per 1 percentage point of inflation. This result appears again rather different from that for China, where the coefficient is consistently positive: for the period as a whole it comes to +0.25 with a t-value over 3, though it is not very stable in the subperiods. But the difference can again be easily reconciled by recognizing the differences in the measurement of the saving ratio with respect to both income and saving. For China the estimated coefficient measures the impact of inflation on the NIA measure of *S/Y*, which corresponds to *k* of equation (4). Cross II instead uses the inflation-adjusted concept, which subtracts from *S* and *Y* the loss in purchasing power of assets carried over. Therefore, the coefficient it estimates is $k(4)$ of equation (6). Now, it can be seen that $k(4)$ is more negative than k by the average propensity to consume *C/Y*. Therefore, for China, where *C/Y* is on the order of 0.8, the value of $k(4)$ can be placed around 0.25 – 0.8 = -0.55, which is right in the range of the Cross II estimates.

Thus the present analysis confirms the finding of Cross II, to the effect that inflation has a strong negative impact on private wealth inflation-adjusted saving. This is especially true of China where nominal wealth is, in recent years, a large portion of private wealth (around ⅔ and somewhat larger than income). To illustrate, we recall that for China, there were a few years of high inflation, reaching a peak of 24 percent. With our estimated impact of 0.55 A^*/Y per point of inflation and a value of A^*/Y around one in recent years, this means a decline in adjusted saving (an impoverishment) close to 15 percentage points!

There are grounds, however, for questioning the interpretation advanced in Cross II to the effect that the large negative coefficient can be interpreted as evidence of serious inflation illusion. This results in a substantial decline in the contribution of personal saving to capital formation. It is true that with zero inflation illusion, and the Fisher law, the inflation-adjusted saving ratio is unaffected by inflation. This can be readily verified. But this conclusion does not justify attribution of a decline in the adjusted saving ratio to an increase in inflation illusion. Why? In the presence of large and/or persistent inflation, nominal interest rates rise, justifying higher consumption, without inflation illusion.

As suggested in section 3.4.1 and equation (5), the loss of contribution to capital formation through inflation is best approximated by the increase in $C/Y(3)$, or $k(3)=c(z-h)A/Y$. To estimate the value of this expression one needs to estimate z, which in turn would require information on prevailing interest rates paid to households during the inflationary episodes. But the official information

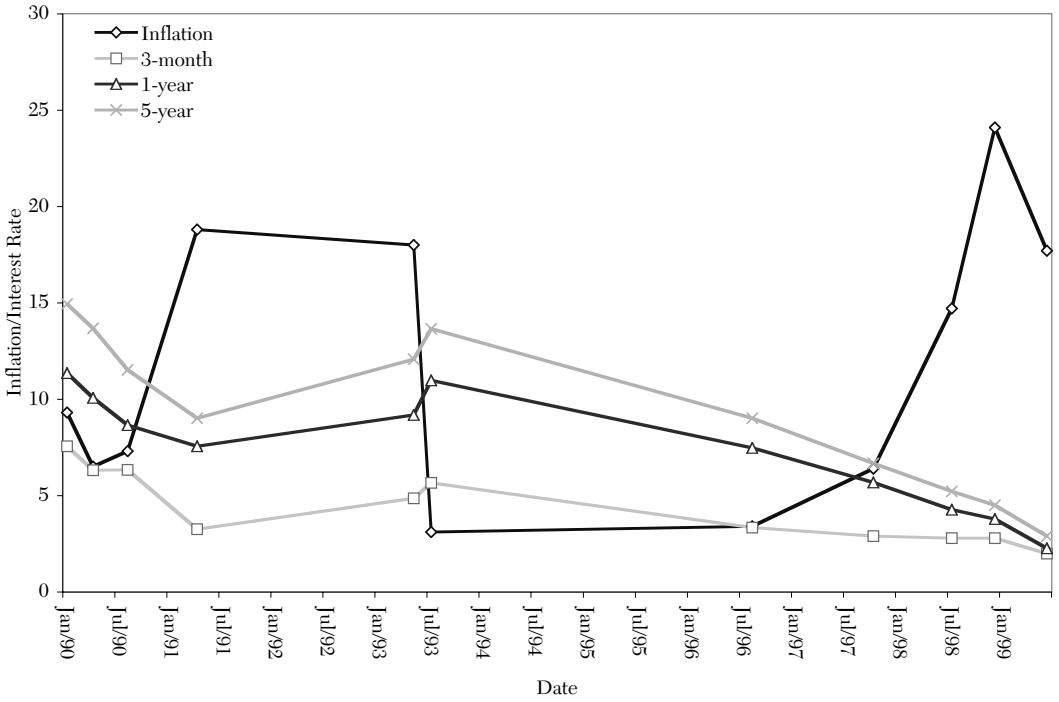

Figure 8: Inflation and Interest Rates

available for China on nominal interest rate appears to be limited in time and quite spotty. It consists of a few points on the term structure of interest rates paid on deposits, at a few arbitrary dates (perhaps the dates at which interest rates are changed?). The information is presented in figure 8, in the form of time series of the rates, for each of three instruments on the term structure: three-month, one-year, and five-year deposits plus the time series of the annual rate of inflation. It is apparent that interest rates do respond to inflation but with a lag and only partially. A more precise answer is especially difficult because of the lack of information for the interval from July 1993 to August 1996 which corresponds with the most dramatic explosion of inflation (24 percent in 1994) and ensuing reabsorption down to 7.5. Educated guesses about z suggests a negative value for $k(3)$ but of rather moderate proportion.

To summarize then:

1. According to the NIA measure of saving, inflation reduces C/Y,(and increases S/Y) by some 25 basis points per 1-percent inflation, because it increases C less than Y. But this conclusion is highly misleading because the NIA measure is faulty in the presence of inflation.

2. Corrected for inflation, income does not rise and therefore consumption increases by $k(3)pA$, and saving by (z-$k(3)pA^*$), presumably positive. However, government saving declines by zpA^*, so that national saving is reduced by the increase in private consumption, $k(3)pA^*$ whose sign we are unable to ascertain but is likely to be small.

3. Finally, inflation has a very large devastating effect on the value of the stock of accumulation of real assets, reducing by an estimated 55 basis points per point of inflation.

TABLE 4
NORMAL SAVING RATIO, GROWTH, AND POPULATION STRUCTURE FOR SELECTED COUNTRIES AND PERIODS

I. Private Saving as Percentage of Private Income (Less Net Taxes)

	Country	Period	S/Y (%)	Y' (%)	M/Pop (%)
1	China	1990–94	29.0	12.0	29
2	USA	1990–94	7.6 (10.0) +	2.3	29
3	China	1958–75	5.3	4.1	49
4	Iceland	1960–70	4.5	4.7	60
5	Japan	1971–80	24.3	9.5	35
6	Italy	1960–70	24.5	5.7	34
7	Average OECD *	1960–70	14.8	4.9	38

* - except Japan

+ - private saving rate: includes corporate saving

II. National Saving as Percent of Net National Product

	Country	Period	NS/NY (%)	Y' (%)	M/E (%)
1	China	1982–88	33.0	10.5	65
2	USA	1990–94	5.0	2.3	46
3	Japan	1971–80	25.0	9.5	35 **
4	Korea	1982–88	31.9	8.2	64
5	Singapore	1982–88	42.5	4.9	67
6	Botswana	1982–88	35.3	10.9	47

** - M/Pop

S/Y	
Y'	rate of growth of real GDP (lagged)
M/Pop	ratio of minors (under 20) to total population (%)
M/E	ratio of minors (under 15) to employment (%)
NS/NY	national saving to national income (%)

6. *Conclusions: The Pervasive Role of Income Growth*

Our conclusion can be most effectively summarized with the help of table 4. By the early 90s, the Chinese personal saving rate had reached a remarkable level of nearly 30 percent with a peak of over 33 percent (row 1). This occurred despite the fact that, even with the high growth rate, the per-capita income remained one of the lowest in the world. These saving rates are stunningly high in comparison with those of the United States, one of the world's richest nations. During those same years, the personal saving rate in the United States was 7.6 percent; and even the "private" saving rate, which is the sum of personal saving and corporate

saving (profit retention), rises to only 10 percent (row 2). Since then the saving rate has slipped further with the personal down to 3 percent and the private rate down to 5 percent—though these low figures may reflect partly a transitory response to the boom in asset values.

When lay people are confronted with these figures, their usual reaction, after rubbing their eyes, is to attribute the huge gap to obvious differences in upbringing and education. This thinking reflects cultural-ethical values attributed to personal thriftiness and risk-taking in different cultures. But, if the reader has found the analysis of this paper persuasive, he should understand that that type of explanation is fundamentally baseless. And the simplest proof is found in this very paper, and summarized in row 3 of table 4, namely, that for a long stretch of very recent time, 1958–1975, the Chinese saving rate was quite low, around 5.3 percent or lower than in the United States.

What then is the explanation? The key to the puzzle, we suggest, is provided by the LCH and its implication that the major systematic determinant of the rate of private saving is to be found in the rate of growth of income and the demographic structure of the economy, while per-capita income, the traditional and commonsensical explanation counts little, if any. According to this model the extraordinary behavior of the Chinese saving ratio is the result of two nearly coincidental sharp turns in two key policies. The first is the movement initiated in the late 1970s toward a market-oriented economy, which, along with a number of very special characteristics of China's society and labor force made possible an explosive growth pattern such as was never seen before. With this development the growth rate jumps from a more or less stable rate of 4 percent (row 3) to a gradually rising (accelerating) pattern reaching some 12 percent but 25 years later.

The second turn regards demographic policies. Until the 1970s the Chinese government was not seriously concerned with population growth, and in fact for a while under Mao there was an endeavor to encourage births. But eventually the view prevailed that to improve the economic well-being of the Chinese population, it was essential to control population growth, and the new policy was announced and strictly enforced to limit the number of children per family (just one in the cities). As noted, this had a double profound effect on the saving ratio. The first was a drastic decline in the ratio of people under fifteen years to working population from 0.96 in the mid-70s to 0.41 at the turn of the century. The second was to undermine the traditional role of the family in providing old-age support to the parents by the children, thus encouraging provisions through individual accumulation. (Note that for purposes of comparison with other countries, the population structure, M/Pop is measured not by population below-fifteen/employed population, but by the ratio of the population below twenty/total population. Because of the larger denominator this ratio is around half as large as M/E.

According to our estimates (equation I.4 of table 3) each of these developments contributed equally more than ten basis points to the rise in the saving rate of some thirty basis points (from 3 percent to 33 percent) with the remainder largely accounted for by the spurious effect of inflation (five basis points).

As a further demonstration that the prodigious saving rate reached by the mid 90s does not reflect "ethnic" or cultural characteristics of China, we report in table 3 illustrative episodes for other countries and periods. First, in row 4, we show the case of Iceland in the 60s when the saving rate was about the same as that of China in the pre-reform years and the lowest of any OECD countries up to the end of the 80s. The growth rate is also low, like that of China, and the population structure is distinctively more unfavorable.

On the other hand, the last two rows of part I demonstrate that China is not the only portentous saver in the world. Japan in the

1970s (row 5) had an exceptionally high growth rate—though not quite matching that of China—and a quite favorable population structure that had a saving rate that nearly matched China's. One might be tempted to say that, after all, China and Japan share the heritage of the East. Unfortunately, such a simple explanation is refuted by row 6, which shows that in the 1960s, Italy saved even a larger fraction of its income than Japan. Yet, one cannot even use the excuse of the "Protestant ethic" since Italy is a solidly Catholic country and many think of it as the "paese della dolce vita"! The explanation can again be found in a growth rate not as high as the other two countries but still well above average (row 7) and a very favorable M/P that reflected the sharp decline in population growth, to which one can probably add the substantial loss of its tangible and intangible wealth during World War II. And a similar story can be repeated for France with a fairly high growth rate of 5 percent, saving 19 percent of its income, and of Portugal with a somewhat higher growth rate and a saving ratio of nearly 20 percent.

Row 7 shows the same information for the average of all the OECD countries for the decade of the 60s when the growth rate reached a peak of 4.9 percent and the saving rate also peaked for most countries with an average of 14.8 percent. Both are impressive by today's standards. By the 1980s, the average growth rate had declined to below 3 percent and the saving rate to 14.4 percent. The inflation-adjusted saving rate had declined even more, from 14.8 percent to 12.3 percent.

Part 2 of table 3 presents some further comparative statistics for the national saving rate—the sum of private and government saving expressed as a percent of national income. This measure reflects not only the behavior of the private sector but also the fiscal policy of the government, and to that extent, needs not respond closely to growth or demographic composition. In the case of China (row 1), as we have seen before, it was a gigantic 33 percent—higher than the already mammoth personal saving rate. It reflected a fiscal policy aimed at supporting the rapid development of the country through high saving and investment.

On the other hand, for the United States (row 2) the national saving rate in the first half of the 90s was appreciably lower than the already low private saving rate, 5 percent versus 7.6 percent. This difference reflects the difficulty of reversing the policy of huge government deficits that characterized the Reagan presidency.

But the most impressive figures of part 2 are those in rows 4 and 5. The first shows that the Chinese record was nearly matched by that of Korea, another high-growth country bent on pushing saving. But row 5 reveals that both Korea and China were overshadowed by Singapore that had an incredible saving rate of 42.5 percent. But this huge accumulation did not result from growth, which was less than 5 percent. Instead, it was the result of a draconian policy that required all workers to make very large annual contributions to a pension fund (which can be used ahead of retirement for a variety of purposes other than current consumption).

The last row shows another bit of surprise provided by Botswana, a country for which the estimates are taken from Modigliani (1990, table 5), who in turn relied on information from the IMF. It appears that this country had an exceptionally high growth rate and a national saving rate even higher than China's.

In bringing this paper to a close, there is a strong temptation to try to use what we have learned to peek into the future of the Chinese saving ratio. All indications point to the likelihood that the ratio has already passed its crest. This presumes that China will manage to avoid the repetition of bouts of high inflation, as occurred especially in the early 1990s. The "dependency" ratio has already fallen dramatically to a level comparable with that of countries with little

growth and there is not much room for further maintainable declines. As for the growth of income, it is difficult to imagine that China could improve on, or even maintain, the enormous current rate. It is instructive to note in this connection that Japan's growth rate after reaching 8 percent in the 1950s rose further to 9.5 percent in the next decade. It then declined gradually to less than 4 percent two decades later. In addition to these critical variables, one must recognize that private saving could be significantly impacted by a future public retirement system having universal or at least wide coverage.

We would like to express our heartfelt thanks to China for providing such a powerful experiment! There are considerations and limitations that underlie the "forecast" we have ventured to set forth above. But in the words of an old Italian saying, "He who shall live shall see"!

Appendix

The first of this series of papers was published in 1996. The data used were from 1953 to 1993. In 2002, we decided to update this paper to include data up to 2000.

For the 1996 study, most of the data were obtained from various annual issues of *China Statistical Yearbook*, published by the National Bureau of Statistics, People's Republic of China. During the course of the current study, we found that some of the data definition reported by the Chinese National Bureau of Statistics had changed in the interim. In 1999, the Chinese National Bureau of Statistics published *Comprehensive Statistical Data and Materials on 50 Years of New China* (referred to as *50 Years of New China* in this study), which contains data from 1952 to 1998. Some of the data in this publication are different from those found in the earlier editions of *China Statistical Yearbook*. The data reported in *50 Years of New China* are consistent with the data published in the 2000 and 2001 *China Statistical Yearbook*. We decided that it was best to use a consistent set of data. For the current study, most of the data are obtained from *50 Years of New China*. Additional data were obtained from the 2000 and 2001 *China Statistical Yearbook*. Some supplemental data were obtained from earlier edits of the *China Statistical Yearbook*.

The details of the data sources and some of the differences in the 1996 and the 2002 data sets are listed below:

Parameter	2002	Comments
Price index	Table A-20 Overall Price Indices of China, General Consumer Price Index, *50 Years of New China*, p. 20; *Statistical Yearbook of China* 2001, p. 281.	The 1994 issue of *Statistical Yearbook of China* includes overall retail price indices from 1978 to 1993. It also includes overall consumer price indices from 1985 to 1993. One would deduce that the complete series of consumer price indices was not available prior to 1985; the first study was conducted in 1994.
Personal consumption	Table A-6 gross domestic product by expenditure approach of China, household consumption, *50 Years of New China*, p. 6, *2001 China Statistical Yearbook*, p. 62.	The household consumption figures used in the 1996 study were slightly higher than those in the 2002 study.

Saving	Calculated: change in (currency + deposit) + bonds (new issues) + individual investment in fixed assets.	Currency in circulation: *50 Years of New China*, p. 65; *2001 China Statistical Yearbook*, p. 638. Total saving deposits: *50 Years of New China*, p. 25; *2001 China Statistical Yearbook*, p. 304. Bonds, domestic debt issued, payment for principal and interest of domestic debts, *2001 China Statistical Yearbook*, p. 249. Individual investments in fixed assets: 1953–79 from People's Bank of China; 1980–2000, *2001 China Statistical Yearbook*, p. 158.
Total population	Table A-1 Population of China: total population, *50 Years of New China*, p. 1; *2001 China Statistical Yearbook*, p. 91.	
Population profile	Interpolated from total population and population profile reported in: Table 4-4 *Basic Statistics on Nation Population Census* in 1953, 1964, 1982, 1999 and 2000; *2001 China Statistical Yearbook*, p. 93.	
Number of employed persons	Table A-2 Employment, staff and workers of China, total number of employed persons, *50 Years of New China*, p. 2; *2001 China Statistical Yearbook*, p. 108.	

References

Davidson, Russell and James G. MacKinnon. 1993. *Estimation and Inference in Econometrics*. Oxford U. Press.

Engle, Robert and Clive Granger. 1987. "Co-integration and Error Correction: Representation, Estimation and Testing," *Econometrica* pp. 251–76.

Feltenstein, Andrew; David Lebow and S. van Wijnbergen. 1990. "Saving, Commodity Market Rationing, and the Real Rate of Interest in China," *J. Money, Credit, Banking* 22:2, pp. 234–52.

Guo, Shuquing and Wenxiu Han. 1991. *Zhongguo GNP de Fenpei he Shiyong* (Distribution and Application of China's GNP), Beijing.

Holland, Tom. 2002. "China's Pension Puzzle," *Far East. Econ. Rev*. 165:21, pp. 42–43.

Horioka, C.Y. "Why Is Japan's Private Saving Rate So High?" in *Developments in Japanese Economics*. R. Sato and T. Negishi, eds. Tokyo: Academic Press.

Houthkakker, H.S. 1965. "On Some Determinants of Saving in Developed and Underdeveloped Countries," in *Problems in Economic Development*. E.A.G. Robinson, ed. London.

Keidel, Albert. 1992. "How Badly Do China's National Accounts Underestimate China's GNP?" mimeo, SAIS.

Modigliani, Franco. 1970. "The Life Cycle Hypothesis of Saving and Intercountry Differences in the Saving Ratio," in *Induction, Growth and Trade, Essays in Honor of Sir Roy Harrod*. W.A. Elits, M.F. Scott, and J.N. Wolfe, eds. Oxford.

———. 1989. "Life Cycle, Individual Thrift and the Wealth of Nations," in *The Collected Papers of Franco Modigliani.* Simon Johnson, ed. Cambridge, MA and London: MIT Press.

———. 1990. "Recent Declines in the Saving Rates: A Life Cycle Perspective," *Revista diPolitica Econ.*, Dec., pp. 5–42.

———. 1996. "The Life Cycle Hypothesis of Saving, the Demand for Wealth and the Supply of Capital," Social Research.

Modigliani, Franco and R. Brumberg. 1954. "Utility Analysis and the Consumption Function: An Attempt at Integration," in *Post-Keynesian Economics*. Kenneth Kurihara, ed.

Modigliani, Franco and Arlie Sterling. 1983. "Determinants of Private Saving with Special References to the Role of Social Security–Cross Country Test," in *The Determinants of National Saving and Wealth*. Proceedings of conference held by Int. Econ. Assoc. at Bergamo, Italy. F. Modigliani and R. Hemmings, eds. London.

Modigliani, Franco and Robert J. Shiller. 1973. "Inflation, Rational Expectations and the Term Structure of Interest Rates," *Economica* Feb. pp. 12–43.

National Bureau of Statistics. *Zhongguo Tongji Nianjian* (China Statistical Yearbook), various issues. Beijing.

———. *Zhongguo Chengzhen Jumin Jiating Shouzhi Diaocha Ziliao* (China Urban Households Income-Expenditure Survey Data), *Urban Socio-Economic Survey*, various issues.

———. 1999. "Comprehensive Statistical Data and Materials on 50 Years of New China," Dept. Comprehensive Statistics, China.

Rao, P. and Z. Griliches. 1969. "Small Sample Properties of Several Two-Stage Regression Methods in the Context of Auto-Correlated Errors," *J. Amer. Statist. Assoc*. 63, pp. 243–72.