

Asset rich and cash poor: retirement provision and housing policy in Singapore

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Abstract

National defined contribution pension systems have long been a mainstay of retirement income in Asia. One of the oldest and best known of these systems is the Singaporean Central Provident Fund, a mandatory retirement scheme managed by the central government for almost a half-century. With required contribution rates that have ranged up to 50%, this program has powerfully shaped asset accumulation patterns and housing portfolios. This paper explores how the structure and design of the Singaporean retirement and housing schemes influence wealth levels and asset mix at retirement. Our model indicates that outcomes rest critically on the interlinked national retirement and housing programs. We show that policies to enhance one program may boost retirement replacement rates but can also lower total wealth in unexpected ways. The lessons we draw may serve as guidance for other countries constructing a national defined contribution retirement system.

National mandatory defined contribution pension schemes have become popular vehicles for retirement saving in many Western nations of late, including in Australia, Argentina, Chile, and Mexico, among others.¹ This trend suggests that the national retirement system of Singapore is of particular interest, in that its Central Provident Fund (CPF) was established almost a half-century ago and is seen as the most prominent example of what a serious and long-term national commitment to defined contribution pensions can engender. In this paper, we explore how key design features

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¹ See Mitchell and Barreto (1997).

of the CPF scheme interact with the national housing policy to shape workers' saving and asset accumulation patterns. We also assess how well future retirees under the system may be protected against retirement insecurity and instability in housing returns. We show that in powerfully shaping saving and investment patterns, this system has the potential to render citizens 'asset rich but cash poor' in retirement. Better management of retirement risk may require system-wide changes to help the nation respond to the economic challenges of rapid population aging.

The outline of the paper is as follows. First we outline the structure of Singapore's retirement system, focusing on the links between the national mandatory provident fund structure and other types of asset accumulation in the nation. Next, we scrutinize the interaction between the retirement system and housing investment decisions, exploring in particular how government policy interlinks asset accumulation paths. Subsequently we devise a model that helps us assess how the retirement and housing system might evolve going forward under a set of 'baseline' rules, and we also characterize retirees' expected asset levels and the anticipated mix of assets under baseline rules. A range of alternative cases is also explored. Last we evaluate the adequacy and liquidity of retirement assets anticipated as the Singaporean population ages. The paper closes with a discussion of policy options.

1 The Singaporean National Provident Fund

Singapore's strategic location, strong economy, and educated population makes it one of the more robust economies in Asia (Harris, 1996). In 1999 annual earnings averaged S\$33,600, or about US\$17,000 (US\$1 ~ S\$2). With the exception of the period following the Asian financial crisis, this nation's economic performance has been quite solid partly as a result of high levels of educational attainment: one-third of the population now has at least some post-secondary education (Statistics Singapore, 2000). Despite this strong economic performance in the past, its future growth is less certain, due partly to the looming challenge of a rapidly aging population. Singapore has one of the world's lowest fertility rates (~ 1.2 per 1,000²) and longest life expectancies (over age 80 at birth; Clark, 1999 and US Census Bureau, 2000). Consequently Singapore will soon be one of the most elderly countries in East Asia, as measured by the proportion of the population aged 65 and over (see Table 1). In fact, in just 25 years, Singapore's elderly contingent will be second only to Japan's, making it an older nation than many of its Asian neighbors and the US.

The economic challenges posed by such rapid population ageing in Singapore will be compounded by low labor force participation rates (LFPR) among those aged 55 and over. Men's LFPRs in Singapore fall after age 55 and are very low compared to other nations in the region after that age. Among women, labor force attachment rates are much lower than those of Singaporean men and at older ages are lower than women's employment rates in Western nations.³ In other words, early retirement has apparently become the norm in Singapore, raising an important concern about the economy's future growth potential.

² The Singapore fertility rate in 2000 was reported as 1.2 by the US Census Bureau. Singaporean sources (Singapore Department of Statistics, 2000) place it a little higher, at around 1.5, but declining.

³ See Singapore Ministry of Manpower (2000) for a discussion of labor force participation in Singapore.

Table 1. *Proportion of population age 65 +*

Country	%		% Change 1998–2025
	1998	2025	
China	6.60	13.30	102
Indonesia	4.0	8.6	115
Japan	16.0	26.8	75
Korea	6.4	16.5	158
Malaysia	3.9	7.8	100
Singapore	6.8	20.0	194
Taiwan	8.2	17.9	118
Thailand	6.0	14.1	135
United States	12.7	18.5	46

Source: Derived from Clark (1999).

These trends raise questions about how the elderly in Singapore may fare in retirement over the next quarter-century, and also about the kinds of policy options available to enhance retirement security. Singapore's old-age retirement system is currently a mixed one, with family relations playing a dominant role in elderly support, while government and private pensions have taken a smaller role. But the traditional reliance on family is declining over time, with fewer older persons having children on whom they can rely in old age – and this pattern will be exacerbated in the years to come unless fertility, or immigration policy, is dramatically altered.

The institution on which many citizens expect to rely in the future is the government-mandated Central Provident Fund (CPF) system. This program was established in 1955 as a means of forced retirement savings;⁴ over time the purpose of the institution has evolved, and today it not only shapes retirement saving but also offers life and health insurance, extensive home-purchase support, and educational accounts (CPF, 2000a). Currently the system controls more than S\$85 B (60% of GDP) and covers some 2.5 million wage and salary employees as well as self-employed persons earning over a minimum level (Asher, 1999b).

In order to better understand the rather complex workings of the CPF system, it is necessary to explore the key linkages between the Provident Fund and the Singaporean housing sector. In the subsequent section we develop a simulation model to evaluate the likely retirement accumulation, housing wealth and asset adequacy patterns of hypothetical workers in the Singaporean national system.

1.1 Central Provident Fund rules⁵

To build a forecasting framework we require appropriate actuarial and economic adjustments for earnings, housing, asset returns, and discount rates as well as mortality rates pertinent to Singapore. The Singaporean Provident Fund levies

⁴ Low and Aw (1997) trace the historical roots of the Singaporean CPF.

⁵ In the summer of 2002, several reforms in the structure of the CPF were proposed by the Economic Review Committee of Singapore (www.erc.gov.sg), including changes to contribution rates, investment rules, and disbursement options. However, when and how many of these proposed changes will be

contributions on employees' regular monthly earnings up to an earnings ceiling of approximately \$6,000/month, which has not changed in nominal terms since 1984. The CPF tax is also levied on bonuses worth up to 40% of regular income (and the \$6,000 earnings ceiling does not apply to the bonuses).⁶ Accordingly our 'base case' scenario represents that of a married employee whose pay is in the middle of the Singaporean employees' earnings distribution, around S\$2,820 per month in the year 2000.⁷ Consistent with national practice, this employee is also assumed to receive two months' bonus salary per year (see the Appendix for more details on model construction and data sources). We have chosen not to model bequests from elderly relatives, as these are likely to be small for the current cohort of Singaporeans.⁸

Real earnings are assumed to grow at 2% per annum, on top of which inflation is assumed to be 2.5% annually.⁹ Earnings growth information is essential since pension contributions depend on pay levels and the worker's age, as elaborated in Table 2. In our base case model we assume that CPF total contributions are 40% of pay before age 55 and lower thereafter (17% for 55–60, 10% for 60–65, and 7.5% after that).¹⁰ Monthly contributions are capped at a salary ceiling of S\$6,000 per worker, a level that we assume is constant in real terms (in the base case; we adapt this in sensitivity analysis).¹¹

Consistent with the law, CPF contributions are allocated to three accounts within the Fund: the Medisave, the Ordinary, and the Special Accounts. Medisave monies can be spent on medical care expenses and catastrophic illness insurance. The Ordinary Account may be devoted to finance home purchases, insurance premiums, education expenses, and 'approved' investments including stock purchase on the Singapore stock exchange. The Special Account must be saved for old-age purposes, but may also be invested in 'approved' assets. Just as total contributions vary with age, so does the breakdown of the allocations across funds.

In the 'steady state' a young worker would have 6% of his total contribution dedicated to the Medisave Account, 30% of his total to the Ordinary Account, and

implemented is unclear, so here we analyze the CPF system as it stood in mid-2002; the impact of any reforms will be the subject of future work.

⁶ Employer and employee contribution rates were higher in the past, reaching a total 50% between 1984 and 1986, but were reduced to 40% and then 35%, the latter in response to the Asian financial crisis (Swales 2000). The government has indicated in interest in returning to the 40% long-term combined rate in the future.

⁷ The proportion of workers contributing to the CPF who earned less than S\$30,000 per year (excluding bonuses) in 1999 was approximately 62%. However, as there are significant differences between the earnings of males and females (average wages of \$39,000 per year for males in 1999 for males and \$28,000 per year for females in 1999), our salary assumption is probably a reasonable estimate for median male earnings in 2000. These figures are from Ministry of Manpower (2000). We do not model the income tax treatment of earnings since fewer than 30% of Singaporeans pay income tax and for them the top marginal rate is 28%.

⁸ The taxation of all but the largest bequests is extremely low in Singapore. There are hence no significant incentive effects that need to be considered, with the possible exception of the very large tax exemption on residential housing in estates (\$9 million, up to any number of properties), which may further encourage wealthy individuals to invest in housing.

⁹ Chen and Ann (1998), Lian, Valdez and Low (2000) and Swales (2000) also develop simulation models for participants in the CPF over time. We discuss these in more depth in Section 3 below.

¹⁰ In model extensions we also drop the CPF rate to 30%.

¹¹ In 2000, the government capped CPF contribution rates for prime age workers at 32% as an anti-cyclical device, but it intends to return to initial (pre-Asian crisis) contribution levels as soon as practicable. As of 1992, all self-employed persons are also meant to be included in the scheme (CPF Board, 2000a).

Table 2. Combined employer/employee contribution rates to the Singapore Central Provident Fund by age and plan account (%)

Age (from)	Long-term target				1999 rates			
	Ordinary	Special	Medisave	Total	Ordinary	Special	Medisave	Total
22	30.0	4.0	6.0	40.0	24	2.0	6.0	32.0
35	29.0	4.0	7.0	40.0	23	2.0	7.0	32.0
45	28.0	4.0	8.0	40.0	22	2.0	8.0	32.0
55	12.0	0.0	8.0	20.0	9	0.0	8.0	17.0
60	7.0	0.0	8.0	15.0	2	0.0	8.0	10.0
65	2.0	0.0	8.0	10.0	0	0.0	7.5	7.5

Note: In 1999–2000 total contribution rates were lowered in response to the Asian financial crisis and its impact on the domestic economy. These are slated to return to the long term goal in the near term.

Source: CPF Board (2000).

4% to the Special Account. The 55-year old worker, by contrast, would by law make only a 20% total contribution, divided as 8%, 12%, and 0% across the three separate funds.¹²

Investment choices are constrained in the CPF, unlike in the more flexible defined contribution models now popular in the Western hemisphere. Thus as a Singaporean worker accumulates an asset position in his CPF account, his funds are initially invested by the CPF Board and are credited government-set rates of return that can vary over time. Of late, the CPF Board has paid a minimum (nominal) interest rate of 2.5% on Ordinary and Medisave Accounts, and an additional 1.5% on the Special Account. These rates are described by the government as ‘market-related’ averages of the 12-month deposit and saving rates of the four key local banks.¹³ Of course if inflation were to exceed 2.5%, resulting interest rates would move close to zero (or could be negative; Asher, 1999b).

The participant may also choose to invest his Ordinary Fund and Special Fund assets in one of several ‘approved’ banks which then allow a worker to allocate his excess assets across a portfolio that includes government bonds, Singaporean equities, corporate bonds, mutual funds, and gold as well as time deposits (CPF, 2000b).¹⁴

¹² Allocations to the Special Account are currently lower due to the Asian crisis but are likely to return to previous rates in the next few years.

¹³ Asher (1999) notes that this rate is set as a weighted average of the 12-month deposit rate (80%) and last-month savings deposit rate (20%) subject to a minimum 2.5% nominal return, revised quarterly. He also argues that actual CPF returns probably returned 5% on average, on an internationally invested asset pool of about S\$60B over the last decade, though no firm data are provided on the investment mix and returns of the CPF portfolio.

¹⁴ It would appear that no direct foreign investments may be held in this account, but people may purchase individual shares and participate in initial public offerings (IPO's). Until August 2000, the individual was required to accumulate a minimum balance of S\$65,000 in the Ordinary Account before any surplus could be invested in the Central Provident Fund Investment Scheme (CPFIS). In addition, prior to August 2000, only the Ordinary Account could be invested in this way; after this date both the Ordinary

1.2 Access to CPF assets during the accumulation phase

A worker accumulating assets in the CPF cannot elect how much to contribute to the fund, but he does face the decision of whether he should leave his assets in the CPF as he moves through time, or whether he should use his accumulation for other purposes. Most importantly, he is permitted to dip into his accumulating Ordinary Account CPF funds to buy a home even before he has attained the Minimum Sum.¹⁵ Hence the CPF permits participants to access a portion of the funds prior to age 55.¹⁶ Table 3 contains a summary of many of the key features of the CPF.

In Singapore CPF savings have long been tied to housing investment, beginning in 1968 under Prime Minister Lee Kuan Yew who introduced the Home Ownership Scheme (HOS). The thrust of this program was to permit workers to use their CPF accumulations to purchase public housing built under the auspices of the Housing Development Board, which is the government authority controlling most of the island's housing stock. Under this format, HDB 'standardized' flats were constructed in the thousands by government-operated firms and sold at highly subsidized rates to workers whose ownership rights would extend 99 years.¹⁷ The HOS plan was encouraged on the grounds that home ownership generated positive externalities, public spiritedness, a sense of belonging, and 'good social behavior' (Low and Aw, 1997: 45). Today 81 % of the population owns an HDB flat, and over 95 % of the adult population are homeowners (HDB, 2000).

The particular mechanism by which a CPF account may be turned into housing is essential to understand in order to clarify the links between retirement accumulation and housing. In Singapore, an eligible worker may use up to 100 % of his Ordinary Account CPF savings as a down payment for his house or flat. In addition, up to his entire monthly CPF Ordinary Account contributions may be used to service his mortgage payment (CPF Board, 1999).¹⁸ The mortgage loan rate is explicitly set by the government to be 0.1 % above the floating nominal CPF Ordinary Account interest rate, which has recently been 2.5 %. This mortgage rate is attractive in view of the 4 % real return on housing in Singapore over the last 15 years (Singapore Dept of Statistics, 1999). Whether such strong housing market returns continue in the

and the Special Accounts could be invested outside the CPF. Of the available CPF balances of S\$90 billion, only around S\$30 billion had been invested in these approved investments as of December 2000 (CPF Annual Report, 2000). Both of these figures exclude all investment of CPF funds in housing. In addition, a January 2002 News Release on the CPF Investment Scheme (CPF Board, 2002), shows that only 37,000 CPF members made any significant profits (> S\$1,000) on their investments over the CPF interest they would have received had they not participated in the CPF Investment Scheme. For this reason, the analysis that follows does not devote special focus on the CPF Investment Scheme.

¹⁵ As long as the mortgage payments are no higher than 24 % of income (HDB 2000).

¹⁶ As noted above, he may also use the Ordinary Account assets to purchase mutual funds or shares, or to invest the money in education.

¹⁷ Subsequently the program was extended to include private homeownership but private development is restricted to small portions of the island.

¹⁸ Workers may not deduct interest payments on their first mortgage for CPF mortgage payments. Technically the downpayment should be paid by the worker out of non-CPF funds, but if necessary a bridge loan can be obtained and accumulated CPF funds can be used to repay the loan (CPF Board, 1999: 4). The eligible worker seeking to buy a flat directly from the HDB must be a resident national over the age of 20, and have total income of under S\$1,500 for a three-room flat or and \$8,000 for a four- and five-room flat (HDB, 2000). Resale flats may be purchased on the open market with CPF funding if the buyer earns under S\$8,000 per month and has no other active HDB subsidy.

Table 3. Key features of the Singaporean CPF

	Comment
Coverage and eligibility	
Minimum age	22
Minimum pay	Complicated but low
Participation	Citizens or permanent resident employees
Contribution structure	
Earnings definitions	Annual earnings plus bonus
Rate	See Table 2 (based on age)
Earnings ceiling	S\$72,000 annually
Tax status	Employee, employer contributions not subject to income tax
Fund uses	
3 Accounts:	
Medisave	Medisave, Ordinary, Special
Ordinary	For medical expenses and insurance
Special	For housing, education, share ownership
Money management	Must be preserved until age 62
Medisave	
Ordinary	Government invests
Special	Government invests in-house portion; balance over Minimum Sum may be invested in approved S. assets mg'd by private firms
CPF asset portfolio	Government invests
Rate of return	70% Sing Govt Bonds (non-tradeable), 30% Sing Monetary Authority Deposits
	Medisave: Same as Ordinary Account
	Ordinary: Min of 2.5% nominal p.a. or average of 12-mo deposit rates from four major banks
	Special: Ordinary + 1.5% nominal p.a.
Tax status	Exempt
Preservation requirements	
Withdrawal age	55: Must set aside Minimum Sum and may access the rest as lump sum or annuity
Minimum Sum preserved	Currently \$65,000, slated to rise to \$80,000 (half may be property)
Retirement age	62
Payout format and rules	
Form of benefit	Minimum Sum: annuitize or minimum distribution
	Excess > Minimum Sum: annuitize or lump sum
Tax status	Retirement benefits taxable if monthly income > 40% of CPF contributions
Bequest conditions	
Tax status	If decedent has surviving spouse, Minimum Sum goes to survivor. If Minimum Sum formed by children topping up, children's CPF funds are repaid

Table 4. *Key features of housing subsidy program in Singapore*

		Comment
Buying a first home		
Eligibility	Citizen, age 21+, has family nucleus	HDB 2000
	Has down payment in Ordinary Account	HDB 2000
	If HH income low enough gets capital subsidy	HDB 2000
CPF Funds for down payment		
Ordinary Account	100% of purchase price	CPF 2000c
CPF Funds for mortgage payment		
Ordinary Account	100% of monthly contributions	
Special Account	Permitted for older properties only	CPF Bridging Loans: 1
Purchase subsidy	Grant of S\$40–50K if live near/with parents	Low & Aw: 52
	Low income are subsidized through below market rate on purchase price for HDB flat	HDB 2000
Mortgage interest rate	CPF Ordinary interest rate + 0.1% for admin (now 2.6%)	HDB 2000
Charge at sale	Loan to be repaid to CPF	
	If sale > purchase price, must also repay CPF interest earned as though loan had not been taken out	CPF 2000e
	If received capital subsidy, HDB gets 22.5%–25% of home sale price	
Rationing	Dwelling allocation based on income and family ties	CPF 2000e
	First-time buyers preferred	
Upgrading		
	Similar conditions apply for second-time (or more) buyer	
	Capital subsidy may not apply	

Table 5. *Housing accumulation and decumulation patterns in Singapore by age and dwelling size*

By age	Per cent of 1990 housing stock	
	Upgrading	Downgrading
< 30	4.2	2.6
30–39	21.5	9.6
40–49	13.8	6.6
50–59	4.5	2.4
60+	3.0	2.8

By dwelling type	Per cent of 1990 housing stock	
	Upgrading	Downgrading
Initial dwelling type		
HDB Flats		
1 & 2 Rm	27.0	0.0
3 Rm	18.0	2.6
4 Rm	11.0	6.8
5 Rm	11.0	11.2
Exec/6 Rm	10.0	11.4
Private housing	0.0	21.6

Source: Derived from Department of Statistics (1997: 4 & 6).

future (Ong, 2000) is less certain, particularly in view of the fact that property indexes have fallen over 20% in the year 2000 and declining fertility rates may undermine future housing demand. (We examine sensitivity to these future appreciation rates in our simulation analysis, below.)

Not only does the HDB offer low-interest loans for home acquisition; it also provides eligible buyers with a large subsidy toward their purchase price. This is evident from the long waiting lists for HDB flats (recently as high as three to five years in duration; lately these have been much shorter), and it underscores the substantial difference between the market price of an HDB flat and the worker's subsidized purchase price. Another subsidy is granted if a household purchases its flat on the open market instead of directly from the HDB, worth S\$30,000.¹⁹ These up-front purchase subsidies come with a later repayment consequence, in that the HDB then has a claim on a resale levy worth 22.5% of the home sale value when applied to a four-room flat (or 25% to a five-room or 'executive' apartment). Excess cash is earmarked to repaying the worker's CPF account with interest, though the worker may use it to 'upgrade' his housing stock by buying a new, larger, flat. Upgrading is accomplished by using the CPF accruals, as well as another HDB purchase price subsidy that must be repaid at the time of the sale via the resale levy. This complex of subsidies, summarized in Table 4, apparently induces substantial investment in housing and upgrading over time, such that more than 20% of the population shifts

¹⁹ Until recently, this subsidy was only granted if the individual purchased a home near his aged parents.

housing in any given year and twice as many upgrade as downgrade. Most housing turnover occurs among workers under age 50; downgrading is rare for the 60+ year olds, amounting to only 3% of all movers. Table 5 contains some recent data on housing accumulation and decumulation patterns in Singapore.

1.3 Provident Fund decumulation patterns

CPF assets must be preserved until the worker attains age 55 in Singapore, except for the uses identified above. At age 55, a CPF member may apply to withdraw cash worth up to half of his CPF assets in his Ordinary Account over the so-called 'Minimum Sum' level. This Minimum Sum has been set by the government as approximately equal to the amount needed to purchase a subsistence-level single life annuity.²⁰ The rationale provided for this minimum is to ensure that the retiree has a retirement income stream without selling his home in his elder years. A 55-year old worker having too little cash savings in both his Ordinary and Special CPF accounts at that point could partly meet the Minimum Sum threshold by pledging property. In addition, a couple's children may also top-up their parents' accounts (and the funds revert to the children if the parents predecease them).

At age 55, funds in the CPF up to the Minimum Sum may be transferred to an approved life insurer to purchase an annuity that will commence at age 62. Private insurers compete for this business, and it is not mandatory that the participant buys a life annuity. Approximately 15% of Singaporean retirees do appear to annuitize at least a portion of their retirement income (Doyle, Mitchell, and Piggott, 2000). Alternatively, the funds can be left with the CPF Board to earn interest (at the Special Account Rate, or 1.5% above the Ordinary Account Rate) and are then paid out from age 62, or invested with an approved bank and then paid out at 62 (CPF, 2000c).²¹ Any Minimum Sum benefit not annuitized can be transferred to a surviving spouse in the event of death and counted against that survivor's Minimum Sum requirement, or paid out as a lump sum if the total is greater.²² The Minimum Sum is being phased in gradually; it is currently slated to rise to S\$80,000 in 2003, again with S\$40,000 that may be pledged as property.

2 A model of retirement accumulation and decumulation in Singapore

To evaluate this complex set of interactions between the CPF and the housing scheme, we have devised a projection model of earnings, contributions, asset accumulation, and housing patterns over the life cycle. The results for the base case are presented first; subsequently we explore other cases to evaluate the sensitivity of results to parameters of key policy interest.

²⁰ In July 2000, the government raised the Minimum Sum from S\$60,000 to S\$65,000, of which S\$40,000 could be pledged in property and the rest of which would have to be in cash (*Straits Times*, 2000). A lump sum of this magnitude would generate a monthly benefit of S\$498 for life. Couples are required to have 1.5 times this amount. This total is slated to be raised to S\$80,000 in annual increments.

²¹ A few occupations may retire at 60 instead of 62.

²² If there is no survivor, the remainder of the Minimum Sum would be paid as a lump sum to his beneficiaries (CPF 2000c). If the children had topped up their parent's account, unused assets would revert to the children's CPF accounts.

2.1 A base case scenario

Our base case analysis relies on the structural framework of the CPF and housing subsidies outlined above, and a set of assumptions (that are summarized in the Data Appendix). All monetary values are given in S\$2,000 terms. The analysis assumes a starting earnings level of S\$30,000 in 2000 for a male worker with a dependent spouse of the same age, a real earnings growth rate of 2%, real housing returns of 4%, and annual real interest rates of 0% and 1.5% in the Ordinary and Special Accounts, respectively. Inflation is assumed to be 2.5% per annum. Housing purchase and sale prices as well as mortgage rates and capital subsidies are as reported on the CPF and HDB websites. Our base case further assumes that the worker buys his first flat as soon as he has accumulated sufficient cash in the Ordinary Account for a down payment, he spends no more than his CPF Ordinary contributions for the mortgage, and he accumulates any extra cash in the CPF until retirement at age 62. At that point he buys an actuarially fair real annuity with his cash accumulation (joint and survivor) and continues to live in his flat without downgrading.²³ Occupational schemes are very rare in Singapore, implying that the individual could only augment his CPF accumulation with private savings.

The retirement annuity thus generated may be compared to two alternative standards of retirement income adequacy. First we assess the earnings replacement rate (EarningsRR), or the ratio of the retirement annuity payment relative to the worker's pre-retirement pay. While there is no single and widely agreed-on 'gold standard' for the replacement rate that retirees require in old-age, Western pension experts typically recommend a target of the order of 75% (McGill *et al.*, 1996). This rate is therefore the adequacy standard used in what follows. The second adequacy target against which the CPF system can be judged is the government-decreed Minimum Sum which retirees are required to have in their fund at retirement. This amount has presumably been selected as a threshold below which income would be inadequate for subsistence. Using this criterion, then, we use as the second adequacy criterion what we term the 'subsistence replacement rate' (SubsRR), which compares the retiree's CPF accrual at retirement with the (real) value of the Minimum Sum.²⁴

Turning to the base case results, Table 6 indicates a range of projected outcomes for the worker at ages 50, 55, 60, and 65; we also provide results for age 62, the national retirement age. In the first two columns the worker's rising real earnings and total wealth are tracked through time, with wealth topping S\$1 million by age 50 including CPF and housing assets.²⁵ Assets continue to grow with continued work, amounting to S\$1.8 million at retirement at age 62. The next panel to the right in the Table underscores the key role played by housing assets in this system. This typical worker would be expected to have around 75% of his retirement assets in housing

²³ Actuarially fair annuities are valued using Singaporean annuitant tables; see Doyle, Mitchell and Piggott (2000) and Fong (2002). The impact of differing annuity costs can be estimated by proportionally reducing the income by the increase in annuity prices over actuarially fair rates.

²⁴ In the analysis reported below we assume that the retired couple needs twice the Minimum Sum to remain at subsistence in retirement, though technically the government requires a married couple to preserve only 1.5 times the Minimum Sum in the retirement system at retirement.

²⁵ This total also includes accumulation in the Medisave account though these funds are not generally accessible for housing or consumption other than health care-related expenses.

Table 6. *Estimated earnings and total wealth, asset allocation, and replacement rates for base case*

Age	Real earnings (S\$000)	Total wealth (S\$000)	Asset allocation (% of total)					Implied RR: retirement income/final earnings (%)	
			CPF: Ordinary	CPF: Special	Housing	Mortgage	Other	Earnings	Subsistence
50	60.9	1093.5	15	6	76	-4	7	17	120
55	67.3	1384.1	16	6	73	-1	6	23	202
60	74.3	1659.1	14	5	74	0	6	26	268
62	77.3	1774.3	14	5	75	0	6	28	296
65	82.0	1955.9	13	5	77	0	5	30	343

Notes: Authors' calculations; all wealth in real 2000 S\$(000); assumes male head of household married to same age non-working wife. See text for other assumptions.

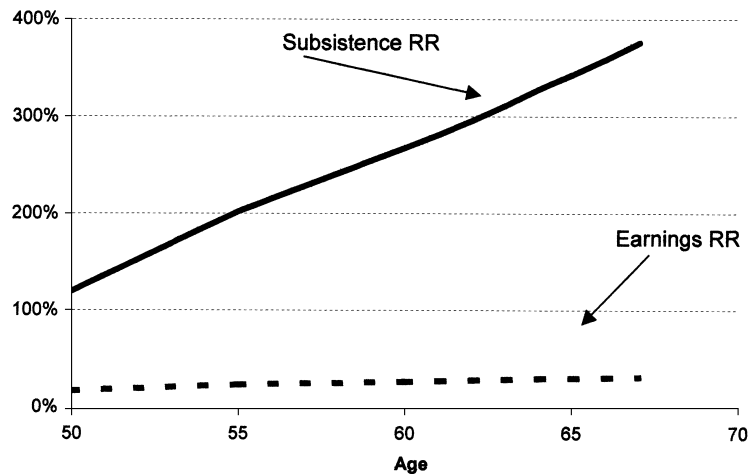


Figure 1. Earnings and subsistence replacement rates by age using base case assumptions

from age 50 on to retirement. This concentration of retirement wealth in housing is much higher than in the US, for instance, where housing wealth for a median older household amounts to only 20% of retirement wealth, including social security entitlements (Moore and Mitchell, 2000).

Liquid assets in the worker's Ordinary and CPF Accounts amount to a relatively stable one-fifth of the worker's total wealth; the dollar value of this fifth does rise over time from to S\$230,000 at age 50, to S\$337,000 by age 62. Parenthetically, we note that continued work pays off quite well, since if the individual continued to work to age 65, his total wealth would rise by S\$182,000 with roughly the same fractional division across asset types.

Next we inquire how large a life annuity the retiree could purchase given his non-housing assets (assuming annuitant survival tables relevant to Singapore). In the base case, the worker is assumed to be married to a wife of the same age, so the joint and survivor benefit purchasable from the CPF cash sum at age 62 would generate a (real) life annuity of S\$21,000 per year. This is approximately a 28% earnings replacement rate, or only one-third of the 75% EarningsRR suggested by retirement planners. Additional years of work to age 65 would have only a modest impact on the life annuity, boosting it to \$25,000, and would raise the replacement rate to only 30%. Turning to the second adequacy criterion, here the picture is much more positive, with benefits for this hypothetical couple totaling almost three times subsistence at age 62. Once again, working longer helps, with the SubsRR rising to 343% if retirement were delayed to age 65. Figure 1 shows how these two replacement rates change as the worker ages, his pay and contribution amounts change, each account earns its respective rate of return, mortgage subsidies are incurred and repaid, and homes are purchased and sold. Figure 2 indicates how the worker's assets are allocated over his lifespan prior to retirement, with housing comprising the lion's share of the account from the age when he purchases his first home.

We analyzed the impact of our initial wage assumption by running the model over a whole range of wages, from S\$11,000 to S\$71,000. The earnings replacement rate

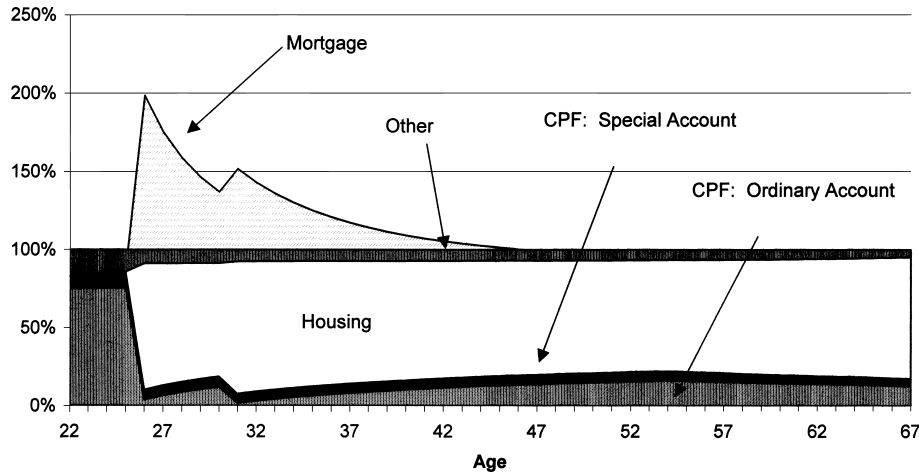


Figure 2. Asset mix by age using base case assumptions

never rose higher than 30% – at higher wage levels, the replacement rate starts to decline. This is because at these wage levels, the individual starts to break through the contribution ceiling near the end of his life, and hence contributes less overall to the CPF. Below S\$30,000, earnings replacement rates rise rapidly from approximately 0% at a non-bonus income of S\$11,000 p.a. to 28% at S\$30,000. The wage-replacement rate profile is shown as Figure 3. It should be noted here that the housing purchase assumption remains unchanged, regardless of income. In other words, the individuals earning S\$11,000 and the individuals earning S\$71,000 purchase the same size house. This is admittedly unrealistic. We did, however, examine the sensitivity of our results to the house purchase assumption, and found our essential conclusions to be unchanged.²⁶

In sum, under reasonable assumptions our simulation model indicates that CPF accumulations at age 62 could generate a relatively small level of liquid income if annuitized, sufficient to cover subsistence but worth only about a quarter of pre-retirement pay in the base-case scenario. Consequently, those households accustomed to higher consumption levels while employed might find themselves in a serious cash bind when retired. While the couple's housing and probably much of their medical care needs are in effect prefinanced by the housing stock and Medisave Accounts, this was also true prior to retirement. Hence the drop in cash flows at retirement may come as a shock to some.

2.2 Responses under alternative scenarios

It is useful to explore how sensitive these results are to a range of alternative scenarios, so as to show how the findings might change given alternative policy outcomes and

²⁶ We examined the impact of three changes to the housing purchase assumption. Firstly, we allowed the family to purchase the second house first, rather than upgrading. This lowered the ERR from 28% to 25%. We allowed the family to purchase houses that were 20% cheaper (this could be done by buying equally sized houses in a less-desirable development), which raised the ERR to 33%. Finally we tested the model if the family chose to stay in the first house and did not purchase the second house. In this case the ERR increased to 36%.

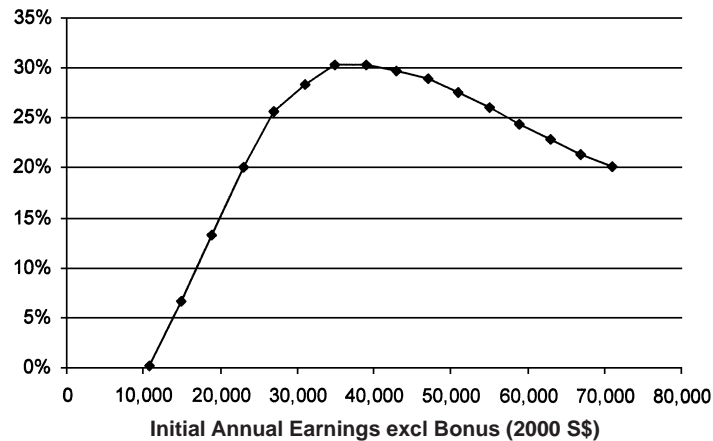


Figure 3. Earnings replacement rate at age 62 using base case assumptions but changing initial annual earnings

economic scenarios. In this section, we report on the impact of four possible changes in the structure of the CPF rules, and five potential changes in the framework shaping housing policy. The hypothetical CPF changes we examine include:

- boosting the CPF return from 0/1.5% real to 5% real on both accounts;
- increasing the flow of contributions to the Special Account from 4 to 8%, holding the total contribution rate fixed;
- holding the CPF contribution ceiling at its current nominal level instead of holding it constant in real terms;
- lowering CPF contribution rates in perpetuity from 40% to 30%.

The hypothetical housing framework changes we model include:

- reducing the assumed real return on housing from 4% to 0%;
- maintaining assumed real housing returns at 4% for 10 years, then 0% thereafter;
- experiencing real housing returns 0% for 10 years, and 4% thereafter;
- decreasing the HDB capital levy from 22.5%/25% to 0%;
- doubling the HDB capital subsidy in real terms.

We note in passing that these policy experiments are not intended as recommendations regarding changes that should be implemented singly or in concert. Also the simulations are not behavioral, in that they assume that employees do not offset plan changes by altering private saving or retirement patterns. Such an extension remains for future research. Rather, our goal is to assess each scenario separately to evaluate how they influence the retiree's asset accumulation, the asset composition, and the adequacy standards of particular interest in the present context.

Results of the sensitivity analysis are provided in Table 7 where for ease of reference we replicate the base case results at age 62 in Line 1. Next we report the impact of the four CPF changes. The first two are anticipated to increase the retiree's cash flow position, since they increase the size of the Special CPF account, either

directly or via an increase in the rate of return. Boosting CPF returns (Line 2) has the larger impact, raising total wealth to over S\$2 million and hiking the earnings replacement rate to 34%. This is in line with Asher's (1998) and Swailes' (2000) view that improving the CPF's investment performance would be a relatively beneficial and possibly low-cost effort. It is interesting that doubling contributions to the Special Account (out of a fixed total, Line 3) enhances retiree liquidity but only relatively modestly. In other words boosting CPF returns may have a larger impact than reallocating the amount going to different accounts within the system.

The impact of cutting the size of the CPF program is represented in Lines 4 and 5, accomplished by either holding contribution ceilings fixed in nominal terms, or by limiting total contributions to 30% of payroll for the entire worklife (both policies have been discussed in Singapore policy circles of late; Swailes, 2000). Either of these two policies produces about a 10% cut in total retirement wealth but a much larger 40–50% drop in the earnings replacement rate (Column C). The reason for this change is that housing accumulations continue at about the same rate due to the relatively attractive rate of return with this asset, so the contribution cut plays out in the form of less liquidity at retirement. Both policies also generate retirement cash flows now only 1.5 to 1.9 times the subsistence replacement rate (Column D), leaving retirees far more vulnerable to inadequate income in old age.

We turn next to the policy experiments involving changes in the housing market and associated policies, and these analyses strongly emphasize the central role that housing policy plays in Singapore's retirement system. For example, if the real rate of return on housing were to fall from 4% to 0% and remain at this new level, this would almost cut in half total wealth accumulation over the lifetime (Column A, Line 6). Though such a drastic shock to the growth rate of housing would seem extreme in the light of long-term patterns, the chance that it could occur is underscored by Japan's recent experience with real estate values remaining depressed for the last decade. It is worth noting that under this experiment earnings and subsistence replacement rates are virtually constant or even rise somewhat, because the worker would be required to wait longer to upgrade his housing and hence would hold more in cash in his CPF account. Earnings and subsistence rates are also fairly stable if the housing return regime changes, as in Line 7 when the rate falls through time or Line 8 where it rises through time. While the retiree's total wealth on Line 7 is less than half that of Line 8, his cash income from the CPF account is more or less invariant across these scenarios.

The last two lines involve changing the extent to which the Housing Development Board increases or decreases the lifetime subsidy to housing purchase. Predictably, lowering the capital levy at resale increases total wealth by 30%, while boosting the subsidy enhances lifetime wealth by 15% (Column A). But more surprising is the fact that these two policies have quite disparate impacts on replacement rates: the first policy increases replacement rates by 21% while the second increases them by 75% (Column C)! The reason has to do with timing: housing purchase subsidies are generally granted to workers when they are young, increasing their ability to get into the housing market early and exposing them to the much higher housing market returns for a longer period of time. By contrast, the capital levy is imposed later in

Table 7. Sensitivity of results to potential policy changes

	Total wealth (S\$000) A	Proportion in housing B	Replacement rate		IRR on Property E
			Earnings C	Subsistence D	
1 Base case	1774.3	75 %	28 %	296 %	5.82 %
CPF changes					
2 Both CPF Accts ROR up from 0%/1.5% to 5% real	2052.6	65 %	34 %	359 %	4.60 %
3 % to Special CPF acct up from 4% to 8%	1800.3	74 %	30 %	319 %	5.34 %
4 CPF contribution ceiling held at 0% nominal instead of 0% real	1598.5	83 %	17 %	186 %	5.23 %
5 CPF contribution rates lowered from 40% to 30%	1604.6	83 %	14 %	148 %	4.61 %
HDB changes					
6 ROR on HDB property falls 4% real to 0% real	768.5	36 %	32 %	339 %	0.77 %
7 ROR on HDB property 4% real → 10 years, 0% real thereafter	749.1	37 %	30 %	322 %	0.47 %
8 ROR on HDB property 0% real → 10 years, 4% real thereafter	1797.6	74 %	30 %	316 %	6.04 %
9 HDB resale levy falls from 22.5%/25% to 0%	2296.2	77 %	34 %	364 %	7.42 %
10 HDB capital subsidy doubles in nominal terms	2037.8	65 %	49 %	526 %	8.84 %

Notes: Authors calculations; all wealth in real 2000 S\$(000); assumes male head of household married to same age non-working wife. See text for other assumptions.

life when a dwelling is sold, a timing pattern that leaves a shorter period over which the impact can be felt.

The last column of Table 7 summarizes the effect of each of these policy experiments in a somewhat different way, by converting them into a real internal rate of return (IRR) on property holdings. This represents the internal rate of return that sets equal to zero the worker's lifetime expenditures minus sales of housing, net of purchase subsidies and capital levies, and after subtracting mortgage payments.²⁷ The IRR on housing for the base case is an appealing real 5.8%, higher than can be earned on CPF contributions left in the retirement fund and also higher than the rate of housing appreciation experienced in Singapore in the recent past. This difference is essentially due to difference in the purchase price and mortgage subsidies over the capital levy on housing. As a result, CPF participants would appear to be quite rational in devoting as much of their CPF Ordinary Account asset as feasible to invest in housing. In other words, it is no wonder that people are asset rich and relatively cash poor under this system, since the incentives appear to favor investment in housing and property upgrading at the earliest opportunity.²⁸

Turning to the policy experiments, it is interesting that none of the CPF-reform scenarios generates an internal return as large as or greater than the base case scenario annual real return of 5.8%. Boosting CPF returns is predicted to cut the IRR on property because the rate charged for the HDB mortgage is assumed to be linked to the return on the CPF accounts. All the other CPF experiments also reduce the IRR, usually because they delay purchase of the house and hence postpone the receipt of the substantial HDB subsidies. The changes in housing policy (lines 6–10) show that the IRR on property sinks to well under 1% in the cases that curtail real housing returns in the long term (not surprisingly). More unexpected is the huge boost in the property IRR resulting from a doubling in the capital subsidy, which ends up making the house investment pay an IRR of close to 9% real. This last policy is unique among those examined, improving all four outcomes examined: total wealth, both replacement rates, and IRR's.²⁹ Least satisfactory according to these four criteria are policies that lower housing wealth, replacement rates, and IRR's.

Figure 4 indicates how many of the various policy experiments fare as retirement is delayed, tracing earnings and subsistence replacement rates with age. It is worth nothing that most of the housing experiments produce replacement rates that are at least equivalent to or dominate the base case. On the other hand many of these housing policies would require additional financing. Most of the CPF reforms have small and often negative effects, with one exception: boosting CPF returns over time. This plan could enhance benefits and avoid additional tax financing, if CPF assets were invested on world markets and the resulting higher returns were passed on to plan participants.

²⁷ All wealth and IRR calculations use house sale prices net of the HDB resale levy.

²⁸ This conclusion does not adjust for differential risk patterns that might accrue to housing versus CPF account values. However since the housing stock is controlled by the government just as is the CPF fund, it is not obvious whether the risk characteristics of the two assets are strongly different.

²⁹ Determining the source of financing for this capital subsidy is beyond the scope of this paper but far from irrelevant, of course.

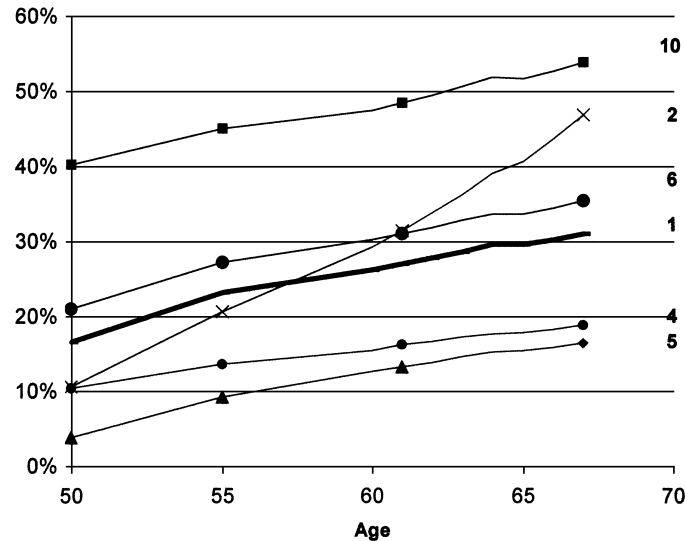


Figure 4. Married earnings replacement rate under alternative scenarios. Numbers refer to the line of each scenario in Table 7.

3 Discussion

Because the Singaporean Central Provident Fund is one of the largest and oldest national defined contribution systems, its workings are of keen interest to would-be pension reformers in the rest of the world. Having explored the structure and design of the nation's retirement system, we have been able to identify several ways in which the design of the retirement income system shapes retirement asset levels and portfolio mix. We find that outcomes rest critically on the interlinked relative returns of the retirement scheme and housing assets: increases in one can boost replacement rates but may lower total wealth in unexpected ways.

Our simulations show that average workers in Singapore are indeed likely to be asset rich and cash poor, as long as housing values continue to rise in real terms. However if the housing market were to take a downturn and remain depressed for years as in Japan, this could reduce retirement asset accumulation substantially. Retirees appear to be able to support themselves at the subsistence level, but they perhaps could do much better if they could access some of the equity in the house.

3.1 Lessons to be gleaned

Our analysis thus far may be summarized according to these key points:

- The average worker in the base case is projected to have substantial retirement wealth of close to S\$1 million or more at age 62 (in today's S\$). Three-quarters of this will be held in housing, and some 20% in liquid form. Annuitizing the latter for a married couple would yield a retirement income that exceeds subsistence targets, but one that replaces only 28% of pre-retirement earnings, a low rate by financial planners' standards. Hence the retirement system

framework does seem likely to render average workers asset rich and cash poor at retirement.³⁰

- Levels of retirement assets as well as the retirement asset mix are critically influenced by the rules and structure of both the Central Provident Fund and the Housing Development Board in Singapore. Boosting the CPF return or the amount deposited in the Special Account (which cannot be used for housing) has the effect of enhancing retiree liquidity, particularly the former policy. Cutting CPF contributions slashes earnings replacement rates by up to half and brings retirees much closer to the subsistence rate in old age.
- A long-term fall in real housing appreciation rates would strongly depress total wealth accumulation and have a smaller impact on retirement cash flows. Boosting the capital subsidy greatly enhances replacement rates since this gets young people into the housing market earlier.
- Each of these policies can be expressed as its impact on the internal rate of return on housing. In the base case, the worker earns an implicit IRR of 5.8% real on housing, implying that CPF participants are rational to invest in housing as early and as often as possible, especially as funds left in the CPF earn approximately 0% p.a. real. It also explains why Singaporeans might end up asset rich and relatively cash poor at retirement.
- Under other policy regimes the IRR on housing falls, sometimes precipitously, with one exception being one where CPF returns are enhanced substantially. Raising the capital subsidy also boosts the IRR on housing.

3.2 Related studies

Our simulation model incorporates all the essential elements of the Singaporean retirement and housing systems in predicting retirement accruals and asset mix. We show that it is essential to include not only elements of how the CPF works but also the national housing model to understand retirees' eventual asset level and portfolio mix positions. This point has yet to be fully recognized in scholarly writings on this topic. In one recent study, Chen and Wong (1998) devise a projection model to estimate retirement income adequacy under the CPF, assuming as here that a worker saves 40% of his annual S\$9,600 annual salary from age 25 to retirement at age 55.³¹ Most critically, however, that study does not take into account the use of CPF accruals for home purchases, so their replacement rate estimates are not comparable with those reported here.

In an actuarial model of replacement rates, Lian *et al.* (2000) compute projected retirement replacement rates after allowing for housing purchases along the way in the Singaporean context. However that study does not take into account the complex subsidies and taxes across different CPF accounts and housing purchases and sales as we have explored here. Chen *et al.* (1997) examine the knowledge and attitudes of Singaporeans towards the CPF. A related model by Swailes (2000) comes the closest

³⁰ Again, we note that housing and medical care needs are in large part covered by the housing stock and Medisave accounts.

³¹ They further assume the CPF rate of return and salary growth are 4%, they set inflation at 3%, and they use a deterministic life expectancy at retirement rather than assessing the annuity flow produced by the cash account.

to the approach we take, but the analysis does not explore the impact of long-term housing price recessions on potential retirement wellbeing. Also these prior studies focus only on earnings replacement rates but then do not evaluate how well retirees do *vis-a-vis* subsistence rates nor do they look at asset mix. To our knowledge, no other international study has devoted adequate attention to the key interactions between pension and housing policy in either the Singaporean or other national contexts.³²

3.3 Useful extensions

To offer further guidance on policy reforms from an economic perspective, it would be necessary to pose and measure adequacy, equity, and efficiency criteria by which specific outcomes and policy reforms can be judged. Above we introduced two *adequacy* criteria, namely the earnings replacement and subsistence replacement rate thresholds, though others might be equally valid. A fuller assessment of the system would also ask whether the program is *equitable* in guaranteeing minimum income to all workers, and whether the program (and retirees) may suffer shortfall possibilities. It would also be useful to assess system *efficiency*, asking for instance whether the concentration of retirement assets in housing produces a risky portfolio that is underdiversified. Though there are social externalities leading policymakers to encourage home ownership, retirees end up rather vulnerable to domestic market risk, particularly in regards to the housing market. Additional extensions could also model potential responses by the various players (e.g. how changes in housing subsidies could influence housing prices); such an exercise is beyond the scope of the present paper.

4 The broader context

Evidently additional asset diversification in the CPF could probably improve retirement system returns while lowering retirees' exposure to potentially large fluctuations in the value of their main asset, housing. This could be implemented by permitting the CPF to invest on the world capital market, or alternatively by moving to an individual-accounts type model where individual plan participants elect their own asset mix. The latter could be accomplished by making the CPF pension scheme into an employer-based 401(k) type pension plan; though occupational pensions are rare in Singapore at present, this model has been adopted in Australia (Bateman *et al.*, forthcoming). Either way, liberalization of asset investment patterns might move CPF participants closer to the international financial efficiency frontier and permit globalization of the accumulation phase. This approach has been followed in several countries that have recently instituted national defined contribution pension systems, including Chile; others, however, others have required the pension system to invest only in government bonds as in the CPF case, most recently Mexico (Mitchell and Barreto, 1997).

One problem in the Singapore context is that permitting pension fund diversification could possibly depress homeowners' housing values, a matter of

³² Some studies of retirement wealth are beginning to acknowledge the key importance of housing equity in the retirement wealth picture; see Moore and Mitchell (2000).

serious policy concern. This raises the more general question of how well the system will be able to survive the demographic transition now facing Singapore along with many of its neighbors. Since the CPF and HDB framework leans so heavily on preserving housing values and the retirement wealth this represents, maintaining their value will likely require encouraging large immigration flows as well as boosting fertility, both difficult social engineering tasks.

One response might be to liberalize housing policy, permitting people to legally rent out their flats or rooms (practices not currently permitted in Singapore). A complementary approach would permit older persons to access some of their substantial housing asset values, so as to preserve old-age consumption. Downgrading one's home is also a way to release capital at older ages, but for older people the need to pay the capital levy can make this an expensive proposition. Alternative approaches might use a home equity loan or reverse annuity mortgage, though neither appear to be popular in Singapore at the moment.³³ Other countries' experiences suggest that it is difficult to write enforceable contracts in this area; that is, there is a substantial political cost for evicting elderly residents from their homes for nonpayment or lack of upkeep of the premises. US evidence also suggests problems of adverse selection and substantial loads in the reverse mortgage market.³⁴ Other policy actions to boost housing prices might include restricting the supply of housing to hold up prices, influencing the supply of and price of mortgages to the same end, changing rental regulations on HDB dwellings, changing immigration policy to attract foreign talent, or maintaining a low return on CPF investments. However these latter policies might not reduce the chances of being asset rich but cash poor in old age.

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³³ Home equity loans were apparently permitted on HDB property in the early 1990s. According to Phang (2001), this was made illegal when it became clear that these loans were fuelling property speculation.

³⁴ Caplin (2000) is somewhat pessimistic about the institutional barriers in the US reverse mortgage market but Mayer and Simons (1994a and b) are more optimistic.

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Data appendix: description of model and assumptions

(See table below for item references)

- (a) *Annual labor earnings*: Total earnings taken from the Singapore Department of Statistics (1994). Starting level updated to 1999 using wage inflation rates for 1990–1999 to produce real (in S\$ 1999) average earnings per month. Monthly average is to S\$2,818, a level that compares well with the 1999 average of S\$2,813 reported by Ministry of Manpower (2000). That report also gives the 1999 monthly rate of pay for men as S\$3,222. These levels translate into approximately 1999 S\$35,000–S\$38,000 p.a.; here we model earnings of S\$30,000 p.a.
- (b) *Labor bonus*: The Singapore report on wages (Ministry of Manpower, 2000) gives average bonus as ~ 2 months salary for each grade of employee, an assumption used in this simulation.
- (c) *Rate of real earnings growth*: Real earnings growth in Singapore has averaged approximately 5% over the 1990s (Ministry of Trade and Industry, 1999). The base case analysis assumes a 2% p.a. real growth rate. Understating real wage growth would tend to overstate replacement rates but understate final retirement wealth.
- (d) *Inflation rates*: Inflation rates in Singapore averaged approximately 2% p.a. over the 1990s, and 1.5% p.a. over the second half of the 1990s (Singapore Department of Statistics, 2000). Our base case models inflation at 2.5% p.a. on the view that this rate is more likely in the future.
- (e) *CPF contribution rates*: The base case assumes that CPF contribution rates stand at the long-term stated level of 40%, split in the traditional way between Ordinary, Special and Medisave Accounts. Short-term deviations from this level (such as the recent reduction to 30% due to the Asian financial crisis) are not modeled in the base case.

Input parameters (all in 2000 S\$ real terms unless indicated)

(a) Annual earnings	30,000
(b) Months of bonus	2
(c) Annual real earnings growth	2.00 %
(d) Annual inflation	2.50 %
(e) Ordinary CPF contribution rate	30 %
Special CPF contribution rate	4 %
Medisave CPF contribution rate	6 %
Employer's CPF contribution rate	20 %
Use age-adjusted CPF contributions	1
(f) Capital appreciation on housing (a)	4 %
Capital appreciation on housing (b)	4 %
Threshold to start using (b) (years)	10
(g) CPF rate of return (Ordinary)	0.00 %
CPF rate of return (Special)	1.50 %
CPF rate of return (Medical)	0.00 %
(h) Medical costs	150
Medical cost escalation	9.00 %
Threshold escalation	0.00 %
(j) First house (purchase price)	155,000
(k) First house (market price)	240,000
(l) Resale levy	22.5 %
Term of first mortgage	25
(j) Second house (purchase price)	255,000
(k) Second house (market price)	370,000
(l) Resale levy	25 %
Term of second mortgage	30
(m) Nominal contribution ceiling inflation	2.50 %
(n) Monthly subsistence income	282
(o) Real subsistence Inflation	0.00 %
Calculated parameters	
Nominal mortgage rate	2.60 %

(f,g) *Rates of return on property*: Flats/condominiums in Singapore have returned 4 % p.a. real since 1985 (Singapore Department of Statistics, 1999). The HDB Resale Index gives a return of 9.5 % p.a. real from 1990–3Q2000 (HDB website 'Resale Price Index of HDB Flats', Yearbook of Statistics 2000). The base case in the analysis uses a real return on property of 4 % p.a.

(h) *CPF Interest rates*: CPF Interest rates in the base case are taken from historical values of CPF rates as quoted on the CPF website www.cpf.gov.sg. Prior to 1998 the Special Account received 1.25 % more than the Ordinary Account; in mid-1998, the law was changed to pay the Special Account 1.5 % more than the Ordinary Account. The CPF Ordinary Account has earned approximately 0 % p.a. real return, historically, so the base case uses 0 % p.a. for the Ordinary and 1.5 % p.a. real for the Special Accounts.

(j,k) *House purchase and sale prices*: House purchase prices are taken from the HDB website ('Average prices of new flats offered in FY 1997/1998'). The base case assumes that all housing costs are denominated in nominal S\$2000. The hypothetical worker is first assumed to buy a four-room flat and then later upgrades to a five-room flat. Sale values are taken from the HDB website 'Average valuation by town and flat type' under the section 'Resale of HBD flats'. Average values are approximate, but we select those in the lower part of the range to account for the easing of house values in the HDB market in the late 1990s.

(l) *HDB Resale levies*: The value of the resale levy is taken from www.hdb.gov.sg and involves a 22.5% levy when applied to a four-room apartment and 25% to a five-room and executive apartment.

(m) *Minimum sum*: The government-specified Minimum Sum applies only at age 55, and seeks to ensure that at 55 people do not empty the CPF of cash, but instead leave some in the CPF account. The base case assumes that the individual leaves all the case in the CPF until retirement (age 62) and then purchases an annuity with the entire proceeds. Even if the individual were to remove all his/her money from the CPF at age 55, the same replacement rate will apply. Currently the Minimum Sum is scheduled to rise to S\$80,000 by 2003, of which half can be pledged in property and half in cash. If one assumes that this level will remain constant in real terms, this is one of various alternative adequacy criteria.

(n,o) *Monthly subsistence income*: The government standard for monthly subsistence income is taken from CPF (2000c) for 1 July 2000–30 June 2001. We assume that this income level is fixed in real terms over time. The subsistence level for couples is assumed to be double that for singles in our computations (though the government requirement for couples for the Minimum Sum is 1.5 times that for single persons).

Nominal mortgage rate: The nominal mortgage rate is calculated as the nominal return on the CPF Ordinary Account plus 0.1%, as specified by the HDB.

Earnings replacement rates: Earnings replacement rates are calculated assuming the retiree buys a simple life real annuity (with no adverse selection and no profit/risk loadings). This annuity is computed on the basis of 5% p.a. nominal interest (the statutory rate specified by the MAS) and mortality is assumed to follow the UK a (55) annuitants table with a lag of three years.

Subsistence replacement rates: This is the proportion of the real monthly subsistence income that the retiree is able to buy at retirement.

Spouse: The base case analysis assumes that the worker is male and married, and he purchases a joint-and-survivor annuity which pays a level real amount until both spouses die. We assume that the wife is the same age as the husband and that her mortality follows the a(55) table for females, also with an age adjustment of three years. We assume that the subsistence income for a couple is twice that of an individual.