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by

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ABSTRACT

While many studies have examined the cost-containment aspect of Medical savings accounts (MSA), few have investigated the adequacy of MSA to finance the health care expenditure. This paper estimates the present value of lifetime healthcare expenses (*PVHE*) of the Singaporean male and female elderly upon retirement at age 62. The estimation involves calibrating the stream of future healthcare expenditure; stochastic forecasting of cohort survival probabilities; and discounting the projected lifetime healthcare expenditure. Estimated values of the *PVHE* under various scenarios are used to assess the adequacy of the government-decreed minimum saving to be maintained in the MSA.

JEL Classification: G00, H51, I18, J11, J14

Keywords: medical savings accounts, present value of lifetime health care expense, cohort survival probabilities

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1. Introduction

Among healthcare reforms in the last decade, medical savings accounts (MSA) have been proposed as an alternative sustainable healthcare financing scheme (see Goodman and Musgrave 1992). Indeed, Schieber (1997) and Prescott (1998) have labelled MSA as 'an innovation' in the design of health financing instruments. In view of the failure of implementing large-scale healthcare reform, Pauly and Goodman (1995a) also proposed the use of MSAs in conjunction with high-deductibles health insurance as an alternative incremental reform.

The appeal of MSA reform comes from its non-distortionary impacts on individuals' incentives and hence is perceived to be efficient.[1] Instead of employers spending on expensive, low-deductible health insurance policy, under MSA plan, employers (and employees) would contribute to a medical savings accounts, which is usually tax exempted. MSA is often accompanied by a high-deductible catastrophic medical insurance, the premiums for which may be paid out from the account. As such, MSA departs from the third-party financing and holds individuals responsible for their healthcare consumption funded from their savings. It thus resolves the over-consumption of health services associated with third party financing and leads to efficiency gains from the elimination of welfare loss caused by moral hazard.

The growing interests on MSAs hinge on their potential positive impacts to contain cost of health spending by making consumers price sensitive and giving

[1] Pauly and Goodman (1995a) viewed an efficient health care policy as one that does not distort individual's choice. It neither encourages nor discourages medical insurance or out-of-pocket medical spending relative to the consumption of other goods or savings.

consumers an incentive to choose appropriate and cost-effective care. However, only a few countries have experimented with MSAs. Singapore is the first country to implement a nation-wide compulsory medical savings, known as the Medisave in 1984. A decade later, in December 1994, China also implemented MSAs for the urban formal sector employees nation-wide, after piloting the scheme in the cities of Zhenjian and Jiujang (Yip and Hsiao, 1997). The United States and South Africa have also recently experimented with voluntary small scale MSAs.

While some economists support the advantages of MSA, others are more sceptical. For example, Shortt (2002) studied the public systems of China and Singapore and conducted simulation analysis based on the United States Medicare data and found that MSA by itself has not controlled costs and may increase inequalities in the publicly funded systems. Like Shortt (2002), both Hurley (2002) and Forget et al. (2002) also concluded that MSAs are unlikely to advance key Canadian health policy goals with respect to cost control. However, Hanvoravongchai (2002) is of the view that the available evidence on the impact of MSAs on health systems is inconclusive, and that MSAs are neither a panacea nor a catastrophe for health care systems, and must be evaluated in the context of the entire financing scheme.

Most research have focused on the efficiency issues of MSAs in terms of cost containment and reducing welfare costs generated by moral hazard. (see also Barr 2001, Pauly 2001).[2] However, this paper concentrates on the very intent of creating the

[2] Hsiao (1995) also concluded that Singapore's MSA itself has contributed less to cost control than the supply side instruments.

savings account. One of the key objectives of Medisave is to mobilize resources for sustainable healthcare spending over the long term. A pertinent issue is whether the accumulated compulsory medical savings would be adequate to fund healthcare expenditures in times of needs. To address these issues, the Singapore government has implemented many regulations regarding the accumulation and utilisation of Medisave.[3] To help fulfil its role as a pre-funded scheme for medical care, a minimum sum scheme was also instituted. Under this scheme, upon retirement at age 62, members are not allowed to withdraw the full amount of savings but must keep a decreed minimum amount with the Central Provident Fund Board.[4]

In this paper, we examine how much medical savings the Singaporean elderly ought to have to adequately finance their medical expenses over the post-retirement period. We begin with a brief review of healthcare financing in Singapore in Section 2. In Section 3, we discuss in details the framework used to estimate the present value of lifetime healthcare expenses of the elderly. These involve three subsections, namely: calibrating the stream of future healthcare expenditure; stochastic forecasting of cohort survival probabilities; and discounting the projected lifetime health care expenses. The projected expenses are calibrated using the survey results of a longitudinal study of transition in health and wealth of the elderly Singaporeans. The survival rates of the elderly are obtained mainly through the well-established Lee-Carter demographic method; and the yield curves are delineated by the Cox-Ingersoll-Ross stochastic interest

[3] The details are given in Section 2.1 of this paper.
[4] The Central Provident Fund (CPF) Board, a statutory board under the Ministry of Manpower in Singapore, administers and manages the compulsory savings scheme. The details are given in Section 2 of this paper. See also Chia and Tsui (2003) for other institutional details regarding the CPF.

rate model and two deterministic models. In Section 4, we present estimates of the present value of the healthcare expenses of the elderly under various scenarios. In Section 5, we assess the adequacy of medical savings accounts and draw some policy implications.

2. Healthcare financing in Singapore

The philosophy of the Singapore's healthcare financing system is based on individual responsibility. To prevent and curb excessive demand, the Government consciously designs policies away from third-party payments and towards cost sharing. This philosophy of co-payment is built into the various health-financing schemes, underlining the idea that there can be "no free lunch".[5] Policy formulation is skewed towards efficiency and less on equity considerations. Patients have to pay part of the cost of medical care and are expected to pay more for higher-level services.

Healthcare financing in Singapore is an integrated system of a compulsory savings account (Medisave), a catastrophic medical insurance scheme (Medishield) and a means-tested medical expense assistance scheme (Medifund). These schemes are generally referred to as the 3Ms. In addition, there is a fourth M which is a managed care which operates within the private health insurance scheme.[6] In what follows, we highlight the main features of healthcare financing in Singapore.

[5] This is in contrast to the WHO's ideal that prepayment as cornerstone of a fair health system financing. The argument being that prepayment affords protection against paying out of pocket, ensures accessibility and allows for efficiency gains through risk pooling. For most countries, the prepayment system operates mainly through the social-security system or national health insurance schemes.

[6] This will not be discussed in this paper as the fourth M has not taken off successfully despite the strong promotion by the government.

2.1 Medical savings accounts (Medisave)

The concept of mandatory savings is not new for Singapore and its introduction was accepted without resistance. As early as 1955, Singapore had already instituted a compulsory savings scheme for old age under the Central Provident Fund (CPF) scheme. Medisave is also administered by the CPF Board. Under the compulsory savings scheme, every employee and employer is required to contribute a proportion of the monthly wage to the CPF. The rates vary according to the age of the employees. The contribution goes into the employee's three accounts: Ordinary Account, Special Account and Medisave Account (see Table 1). These savings while earn interest, are fully tax exempted. Savings in the Special account can only be withdrawn upon retirement but savings in both the Ordinary and Special Accounts can be withdrawn even before retirement for home purchases and other approved investments.

== Table 1 ==

Contribution rates to the medical savings account follow three tiers, with the rates increasing according to age and with a specified maximum contribution per month.[7] There is a set limit on the total amount accumulated in Medisave. As of July 2003, this limit is set at $30,000. The imposed limit is to prevent an excessive build-up of Medisave balance, which may result in unnecessary use of medical services. Although

[7] All dollars in this paper are in Singapore dollars (US$1 approx. S$1.7). Currently, the maximum contribution per month is set at $360 for those aged 35 and below; $420 for those between age 35 and 45 and $480 for above age 45. The average monthly income from employment in 2002 is $3,158. (*Statistical Highlights, 2003*). The average monthly household income is $5,262 (Department of Statistics, *Household Expenditure Survey* 1997/98) and the imputed average monthly household savings is $1,576.

Medisave holders may withdraw the savings at age 55, a minimum sum as set by the CPF Board has to be retained in the account for medical expenses during retirement. In July 2003, the Medisave minimum sum is decreed at $25,000. Upon death, the remaining balance, which is exempted from estate duty, is paid in cash to the account holder's nominees.

Similar to the CPF scheme, the medical savings account also maintains a one-to-one correspondence between contributions and benefits. The ratio of Medisave withdrawals to contributions remains fairly steady at 15 to 100. The average balance per account stands at $8,300 and about 87% of all hospital in-patients made use of Medisave to pay their hospital bills (Ministry of Health (MOH) Annual Report, 2001).

Besides personal responsibility, the compulsory medical savings also incorporates features of family support. This is in line with the official philosophy of promoting family responsibility in the area of healthcare financing. Although Medisave does not allow for risk pooling across individuals, it allows risk pooling among family members (including spouse, children, parents and grand-parents). Indeed, Table 2 shows that children's Medisave has been a major source of healthcare financing for the elderly.

== Table 2 ==

A pitfall of Medisave is that it leads to income effects. The demand for ward types especially for private unsubsidised ward and publicly provided subsidized wards tend to be relatively income elastic. During the period of double digit economic growth from the mid-1980s to mid-1990s, there was a shift in demand towards upgraded hospital

services particularly for better ward class. About half of the private hospital bills were paid using Medisave. Furthermore, in 1993, incomes from Medisave patients comprised about 50-60% of a private doctor's total earnings (MOH, 1993). Prior to the Asian financial crisis, during 1993-1996, the market share for private inpatient discharges increases, with patient load growing at 1% per annum while public patient discharge fell 1.9% per annum. However the pattern of growth changes after the 1997 financial crisis. During 1997-2002, private inpatient discharges fell 6.25% per annum, reversing the 1% per annum growth before the crisis. As for the market share for public sector inpatient discharges, it grew at a positive rate of 0.5% per annum after the crisis.[8]

To minimize the efficiency loss from moral hazard, medical savings can only be used to pay for the relatively inelastic medical demands such as hospitalization and surgery. For out-patient services, Medisave is allowed for only a few relatively expensive treatments (e.g. vaccinations against hepatitis B, procedures for artificial insemination, renal dialysis, radiotherapy, chemotherapy and azimothymidine treatment).

An important issue relating to the utilisation of Medisave is setting the limits on the amount that can be withdrawn. If the Medisave Withdrawal Limit (MWL) is set too low, patients would have to make large out-of-pocket cash payments. If it is too high, it may create incentives for patients to opt for the frills in higher-class wards at the expense of conserving Medisave for old age needs. In the past, MWL depends on the patient's length of hospital stay and the types of surgery performed. However, with effect from 1st January 2004, the Diagnosis Related Groups (DRGs) are implemented for MWL to cover

[8] Data from Khoo (2003).

both inpatient and day surgery cases. The MWLs now vary according to the patient's DRG assigned for the particular hospitalization episode. The utilization of savings thus depends on the resources used and not on the length of stay. More complex DRGs, which require more resources to treat, would have higher claimable limits.[9] The reimbursement is thus simplified with no separate reimbursements for room and board, intensive care unit, surgical operations and implants/approved medical consumables. [10]

2.2 Medical insurance for catastrophic illnesses (Medishield)

To counter the inefficiency loss from the absence of risk pooling and the possible inadequacy of medical savings account, two different forms of insurance are provided. The first provision is in an implicit form, in terms of government subsidies for hospital care. Except for higher class ward A which is unsubsidised, the other lower wards are. The level of subsidy varies according to ward types: 20% of cost for B1 ward, 50% for B2+ ward, 65% for B2 ward and 80% for C ward. A comparison of the different ward classes is given in Appendix 1. The second provision is an explicit low-cost national catastrophic illness insurance scheme (Medishield). Medishield was implemented in 1990 but departed from the open-ended, unrestricted medical insurance as practiced in most developed countries. For economies of scale and to minimize administrative costs, Medishield is administered by the CPF Board.

[9] For patients who stay beyond the high-trimmed point (HTP) for the given DRG, additional reimbursements are given on a per diem basis. The MOH sets the guidelines for MWL, HTP and outlier MWL for each DRG.

[10] It is estimated that with DRG MWL, fewer than 4% of the subsidized patients in B2 class ward (which are entitled to 50% subsidies) in restructured hospitals need to pay out of pocket. Before the introduction of DRG MWL, almost 20% of the B2 class patients had to pay out of pocket. Furthermore, there are proposals to raise the claim limits for Medishield scheme so that patients may claim more for treatment and pay less out of pocket. (*The Straits Times*, March 19, 2003 and *Parliamentary Debates*, 2003)

In the implementation of Medishield, there are built-in guidelines to prevent over-provision of and excessive demand for medical. To prevent an over-provision of medical services arising from third party payments, Medishield operates on a system of negotiated fee schedules to restrict the amount providers may charge the insurers. Control is exercised through limits on the liability per individual and type of illnesses.

To curb excessive demand for medical services, there are limits to claims per individual per policy year and per lifetime. Medishield reimbursements are based on a system of co-payments and deductibles. Deductibles are set high because it is designed to cover catastrophic illnesses. High deductibles are also necessary to keep premiums low and affordable.[11] However, there are no deductibles for out-patient chemotherapy, radiotherapy and kidney dialysis treatment. Medishield premiums can be paid from the medical savings account. The premiums vary across different age groups to minimize cross subsidy. Since inception in 1985, the annual premiums have been kept low and have remained at a range from $12 for those below age 30 and $390 for those between the age of 79 and 80 years old; and there is no Medishield coverage after age 80. As of December 1999, MediShield and an enhanced scheme MediShield Plus,[12] has

[11] MediShield starts paying when the total claimable medical expenses exceed the deductibles. The deductibles are varies from S$500 a year for patients in a ward with 7 or more beds (C ward) to $1,000 a year for patients in other ward classes. MediShield pays 80% of the amount in excess of the deductibles and the insured pays the remaining 20% co-insurance. There is also maximum amount claimable which is set at $30,000 for a policy year and $120,000 for a lifetime. These amounts are based on the average charges incurred by patients in a 6-bedded ward (B2 ward) in a public hospital.

[12] Medishield Plus is an enhanced Medishield Scheme. It caters for those who want to be admitted to higher-class wards in either a public or a private hospital. There are two plans under Medishield Plus. Plan A reimburses up to $623 per day of hospitalization (with a deductible of $4000) and Plan B which pays up to $375 per day (with a deductible of $2500). The premium for Plan A and Plan B are 5 and 3 times of the basic Medishield premium respectively. Medishield has been operating at a deficit for several years. In 2003, it collected $54 million in premiums but paid out $65.3 million in claims. The issue of raising the premium rate is under debate. However, the higher value-added Medishield Plus scheme is in a healthier shape. The 2003 Ministry of Health Annual Report indicates that Medishield Plus collected more than $44

membership of 2.02 million (Ministry of Health Annual Report, 2001). Medisave account holders who are Singapore citizens or permanent residents below the age of 75 are covered under Medishield, as long as they have not opted out of the scheme. An on-going debate is whether to make Medishield compulsory, to increase deductibles and to provide better coverage by increasing the premiums. However these issues are not the focus of this paper.[13]

2.3 Medical expense assistance (Medifund)

While Medisave and Medishield are designed to ensure efficiency, Medifund is designed with equity consideration. As a safety net, Medifund helps to meet the medical needs of the poor and indigent. Medifund was established in April 1993 as an endowment fund with an initial capital of $200 million. Capital is injected into the fund as and when there are overall government budget surpluses. The capital sum currently stands at $900 million, representing about 0.6% of GDP. To ensure sustainability, only the interest income from the capital sum are used. Furthermore, there are strict guidelines on the eligibility to qualify for Medifund support. With means-tested procedures, Medifund serves as a help of last resort for patients who are unable to pay for their medical expenses despite Medishield and Medisave. Only Singaporean patients receiving in-patient treatment in the subsidized lower class wards of B2- and C- Class or out-patient treatment in public hospitals are eligible for financial assistance from Medifund.

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million in premiums but paid out a relatively modest $14 million in claims during the year. Medishield Plus has a smaller policy base of 0.348 million compared to 1.32 million of Medishield.

[13] As of March 2003, 200,000 people (most of them elderly) are not covered by Medishield or any other private medical insurance scheme. *(Parliamentary Debates*, March 2003)

3. Present value of healthcare expenditure

Under the current financing framework, patients in the public sector restructured hospitals are subsidised according to the ward class of their choice. It is the patients' responsibility to ensure that they choose a ward class that is affordable and they are expected to pay the unsubsidised portion of the medical costs. For non-catastrophic illness, the unsubsidised portion is paid out from Medisave (subject to its withdrawal rules) and then from out-of-pocket. For catastrophic illnesses, Medishield reimbursement is available for expenditures that exceed the "deductible" as described in Section 2.2. However, Medishield pays only 80% of the excess up to a pre-set claimable limits [14] Amounts not reimbursable by Medishield would have to be paid out of Medisave, other health insurance plans or out-of-pocket.[15] In cases when the combination of funds fails to cover the medical costs, individuals could seek financial help from Medifund. The fact that Medifund is funded by government budgetary surpluses underlines the government's stand that national health must be attained within the limits of existing resources. Besides, by allowing regular contributors to Medisave and Medishield preferential access to Medifund underscores the importance of individual responsibility to finance health care expenses.

Previous studies on the medical savings accounts in Singapore have mainly focused on whether it has helped to contain medical cost growth (see Barr 2001, Hsiao

[14] In practice, Medishield pays only 40% of the total hospital bill. (Straits Times, 17 August 2004).
[15] Currently 4 in 10 patients in subsidised B2 class wards have medical bills that exceed what they can claim from Medishield. (*The Straits Times*, March 19 2003) An on-going policy issue is to raise claim limits which imply a hike in premiums. (*Parliamentary Debates*, 2003)

1995 and Shortt 2002). We depart from this issue and ask how much the medical savings accounts would be needed for the representative Singaporean male and female elderly to adequately meet the post-retirement healthcare costs. Indeed, the government has instituted a minimum sum scheme in the medical savings account to ensure that account holders have enough funds to meet the medical expenses during the post-retirement. The minimum sum, which is revised regularly to reflect the increased medical costs, is set at $25,000 for year 2003. In our analysis, we do not take this government-decreed minimum sum as given. Instead we estimate the minimum sum that would support the stream of future healthcare expenditures for the elderly at retirement.

Assuming a maximum lifespan of 105 years and that retirement starts at age 62, the estimated present value of healthcare expenses (*PVHE*) of the representative Singaporean elderly is given by:

$$PVHE = \sum_{j=1}^{528} c_j v_{j\ j} P_{62} \qquad (1)$$

where

c_j = calibrated healthcare expenditure for month j

v_j = discount factor at time j

${}_jP_{62}$ = probability of survival of the elderly starting at age 62 up to time $(62 + j)$.[16]

[16] In our calibration of c_j and ${}_jP_{62}$, we distinguish elderly cohorts by gender. But for ease of notation, we do not append the gender subscripts to the terms in equation (1).

3.1 Calibration of healthcare expenditure

The key determinants of healthcare expenses of the elderly depend on the demographic and health sector related factors. Unfortunately, there is no published disaggregated data on the medical expenditure of the elderly by gender and by age. In order to reasonably estimate the medical care expenditure, we make use of an unpublished longitudinal study by Chan (2001) on the transition in health, wealth and welfare of the elderly Singaporeans.[17] The panel survey provides detailed breakdowns of medical expenditure by gender, by age and by socio-economic status identified by different dwelling types. About 85% of Singapore's population resides in public housing, which differ by the number of rooms. In Singapore, housing types reflect the relative economic status among households and in many public policies housing types have been used as a targeting guide. Table 3 presents the average size of housing types and the average and mean income for the different public and private housing dwellers. About half of the elderly in the survey live in the smaller 1-room, 2-room or 3-room public housing. The remaining 43% are in bigger 4- and 5- room public housing; and with only 6% in private housing. The extracted survey data on health expenditures and the corresponding sample sizes by age group and sex are presented in Tables 4 and 5, respectively.

== Tables 3, 4, 5 ==

[17] The longitudinal survey was jointly conducted by the Ministry of Community Development and the National University of Singapore. The survey was conducted in two phases. The first was carried out in 1995 with 4750 individuals aged 55 and above. The follow-up study was conducted in 1999 with about 42% of the original sample data.

We want to point out that the average medical expenditure for the elderly is consistent with the published data on the average hospital inpatient bill size for the three hospitals with geriatric departments in Singapore.[18] Since most of the elderly in the sample under study do not have private health insurance, it is expected that the average inpatient bill for the subsidized ward are reasonably close to the out-of-pocket expenditure. This is further supported by Koh (1998) that the age profile of the insured exhibited a downward trend for the older age group. Those aged 55 and above constituted about 5% of the insured base, while those age 60 and above accounted for only 2%.

Essentially the calibration of future healthcare expenditure involves three steps. First, we assume that the maximum lifespan of individuals in Singapore is 105 years so that the elderly aged 62 in year 2003 will be at age $(62 + x)$ in year $(2003 + x)$, for $x = 1, 2, 3, \ldots, 44$, respectively. The nominal annual healthcare expenditure for the female and male elderly aged $(62 + x)$ in year $(2003 + x)$ can be calibrated by multiplying the base expenditure corresponding to the elderly by gender and dwelling type at age $(62 + x)$ in the survey data reported in Tables 4 and 5 by a cumulative factor assuming at a constant annual growth rate for x years. Second, we pick a flat rate of 4% as the benchmark for the annual growth rate of healthcare expenses. This is because over the period from 1990 to 2001, the published average nominal annual growth rate of medical care in Singapore

[18] Singapore Ministry of Health website at http://www.moh.gov.sg/corp/charges/common/procedures.doc

is about 3.8%.[19] Next, we convert the calibrated medical expenses at age $(62 + x)$ into monthly expenses by taking the monthly average of the calibrated figure within year $(2003 + x)$. Finally, the present value[20] of healthcare expenditure *(PVHE)* of the elderly by sex at age 62 is obtained by discounting the stream of calibrated monthly healthcare expenses, weighted by the survival probability of the elderly over the entire post-retirement period. The choice of discount rates and computation of the survival probability of the elderly by sex and by age will be discussed in Sub-sections 3.2 and 3.3, respectively.

In order to conduct sensitivity analysis of the *PVHE*, we also set the annual growth rates of medical expenditure in Singapore to 3% and 5%, respectively. These growth rates are chosen to mimic the ageing experiences of Japan and the OECD countries. For example, Nakanishi and Nakayama (2001) reported that the medical expenditure in Japan grew at an annual rate of 5.5% from 1980 to 1994. Mayhew (2000), based on the past 30 years experiences of the OECD countries, extrapolated the underlying rate of medical expenditure growth to about 4%. The streams of future monthly healthcare expenditures at these alternative growth rates were then calibrated accordingly as in the benchmark case.

[19] See Chia (2002). One referee perceptively points out that the Singaporean government does not follow the OECD method of compiling its national health expenditures as expenditures on traditional medicine are excluded. Hence, the total health expenditure figures may be understated. We acknowledge this deficiency. However, we do not have access to data on the size of this sector. Moreover, the growth rates of medical expenses among different age groups of the elderly could be different. Again, owing to non-availability of data, we assume a constant growth rate.

[20] *PVHE* is computed in terms of dollars in year 1999. To facilitate comparison with the decreed minimum savings in MSA for year 2003, we further convert the *PVHE* into the dollars in year 2003. Details are given in footnote 25.

3.2 Discount rates

The calibrated stream of future healthcare expenses are to be discounted by the appropriate yield curves. We employ two alternatives to model the structure of interest rates: a stochastic model and two deterministic models. As there are no consensus choice for modelling stochastic interest rates[21], we follow Tse (1995), Lachance et al. (2003), and Chia and Tsui (2003) to generate stochastic interest rates using the following discretized version of the Cox, Ingersoll and Ross (1985) (CIR) short-term rates model: [22]

$$r_{t+1} = r_t + \theta (r_a - r_t) + \beta r_t^{1/2} \varepsilon_{t+1} \qquad (2)$$

where r_t is the short-rate at time t. The second term on the right-hand side of (2) captures the deterministic trend which consists of the long-term average interest rate, r_a , and the speed of mean-reversion, θ, respectively. For $\theta > 0$, r_t is expected to decrease and revert to r_a if the current rate is above the long-run mean, and vice versa. The third term captures the stochastic part, consisting of independently and identically distributed standard normal random variable ε_{t+1}; and β is the volatility parameter.

The deterministic interest rate models used to discount the future cash flows are the constant yield curve (CYC) model and the fixed yield curve (FYC) model. The CYC model sticks to a flat annual rate to discount all future cash flows. Choices include 2%, 3%, 4% and 5%, respectively. In particular, the 4% flat rate can be regarded as the

[21] See "Term-Structure Models" in Campbell, Lo and MacKinlay (1997, Chapter 11).
[22] Tse (1995) is the only available empirical study on the stochastic behaviour of 3-month Treasury-bill rates in Singapore. He finds that the CIR model provides reasonable replicates of the yield curves. Lachance et al. (2003) also use the CIR approach to model yield curves in simulation exercises on option-embedded defined contribution pensions.

average of nominal rates historically paid on the Medisave accounts.[23] The FYC model is constructed using the average of the available historical rates for the government bonds issued in Singapore since 1988. They comprise 2.3% for 3-month bills, 2.5% for 1-year bills, 3.0% for 2-year bonds, 3.9% for 5-year bonds, 3.8% for 7-year bonds, 4.3% for 10-year bonds and 3.9% for the 15-year bonds, respectively. We use the 15-year rate as proxy for spot rates with longer durations. Spot rates for other durations below 15 years are obtained by the method of interpolation.

3.3 Survival probabilities

Appropriate life tables are required to calculate the present value of the estimated healthcare expenses of the elderly. Based on the available 22 abridged life tables from 1980 to 2001, we follow the procedure in Chia and Tsui (2003) to construct the complete cohort life tables.

Basically the construction takes three main steps. First, we predict the future mortality rates of the elderly using the published abridged life tables for Singapore from 1980 to 1999. The following Lee-Carter (LC) model (1992, 2000) is used to fit mortality rates for the male and female elderly of age 62 to 85 and above:

$$ln\, m_{x\,t} = a_x + b_x\, k_t + \varepsilon_{xt} \qquad (3)$$

$$k_t = \mu + \varphi\, k_{t-1} + \eta_t \qquad (4)$$

where $m_{x\,t}$ is the central death rate in age class x in year t; a_x is the additive age-specific constant, reflecting the general shape of the age schedule; b_x is the responsiveness of

[23] We are grateful to two referees for pointing out such an interpretation. The average annual rate is 4% for the period from 10/2001 to 9/2004. See data on interest rates at: http://www.cpf.gov.sg/cpf_info/In.

mortality at age class x to variations in the general level; k_t is a time-specific index of the general level of mortality; μ and φ are parameters; ε_{xt} is the error to the actual age schedule, assuming to follow a normal distribution with zero mean and a constant variance; and η_t is the white noise. Lee and Carter examine the long-term patterns of the natural logarithm of central death rates with the single time-specific index of mortality k_t. A lower order autoregressive process is included to absorb the dynamic relationship of k_t between time $(t - 1)$ and t. The Lee-Carter model has been successfully applied to the G7 countries to forecast life expectancy at birth. See Tuljapurkar et al. (2000).

Second, based on the predicted mortality rates obtained from the preceding step, the abridged cohort life tables are calibrated using techniques developed by Bourbeau et al. (1997). Third, the calibrated abridged cohort mortality rates are converted into annual mortality rates using Pollard (1989)'s methodology. These annual mortality rates are then converted to monthly rates. Finally the monthly mortality rates are converted to monthly survival rates accordingly.

4. Results and discussions

We perform Monte Carlo experiments to estimate the present value of healthcare expenses (*PVHE*) for both male and female elderly at age 62 under the CIR model. Different values of *PVHE* are simulated with 10,000 replications using equations (1) and (2) under various combinations of interest rate paths, growth rates of healthcare expenses, and cohort survival probabilities by sex. All computations and estimations are coded in Gauss. We first simulate the *PVHE* based on the set of benchmark parameters. As

displayed in Table 6, the calibrated parameters for the benchmark scenario include: the 4% medical growth rate; the long-term average rate at 4%, the initial rate at 2%, 3% and 4%; the mean reversion parameter θ at 0.2, 0.3 and 0.4; and the interest rate volatility parameter β at 0.01, 0.02 and 0.03 respectively.[24] For each combination of θ and β, the short-rates are aggregated to obtain the yield curve, which is used to discount the corresponding lifetime healthcare expenses. We repeat the procedure to obtain different *PVHE* corresponding to each of the nine different combinations of (θ, β) along with each of the initial rates. Finally, the reported *PVHE* is the average value of all the simulated *PVHE* from the 27 different combinations of the initial interest rates and (θ, β).

Besides the benchmark parameters, we conduct sensitivity analysis using: [a] different growth rates of medical expenses at 3% and 5%; [b] different long-term average rates at 2%, 3% and 5% under the CIR model; [c] the constant yield curve (CYC) model with flat interest rates at 2%, 3%, 4% and 5% for all durations; and [d] the fixed yield curve (FYC) model based on the average of historical spot rates for different durations, respectively. [25] Tables 7 and 8 report different values of the estimated *PVHE* using alternative parameterisation of medical expenditure growth rates, long term interest rates (r_a) and the deterministic rates.

== Tables 6, 7, 8 ===

[24] These calibrated values are based on the estimation results of the CIR model using the historical 3-month Treasury bill rates in Singapore.
[25] As mentioned in footnote 20, all reported *PVHE* in Tables 7 and 8 are in terms of dollars in year 2003. To facilitate a meaningful comparison with the decreed minimum sum in year 2003, they are adjusted for price inflations from year 1999 to year 2003, which are 1.3%, 1%, -0.4% and 0.5%, respectively.

As can be observed from Tables 7 and 8, the estimated *PVHE* are reasonably robust to the different interest rate models. In particular, the *PVHE* for both the male and female elderly under the CIR and CYC models are all consistently close to each other in most of the scenarios. For example, under the benchmark (i.e., 4% medical growth rate and 4% mean interest rate), *PVHE* for the female elderly in 3-room are $24,557 and $24,676 under the CIR and CYC models, respectively; as compared to the corresponding $24,110 and $24,198 for the male elderly (see Table 7, panel [b]). Similar pattern is observed for those more well-to-do elderly living in the 5-room housing. However, discrepancies of *PVHE* between the female and male elderly become more alarming. For example, at the benchmark scenario, the estimated *PVHE* for the female elderly in 5-room are $38,245 and $38,523 under the CIR and CYC models; as compared to the corresponding $24,614 and $24,727 for the male elderly. See Table 8, panel [b] for details.

The adequacy of MSA may be assessed by comparing the simulated values of *PVHE* with the decreed minimum sum. As can be gleaned from panel [b] in Tables 7 and 8, the decreed amount of $25,000 in the medical savings accounts would be adequate for both the female and male elderly in the smaller 3-room and for the male elderly in the bigger 5-room at 4% medical expense growth rate and at higher discount rates of 4% or above. For the female elderly in 5-room, the decreed sum would be inadequate to meet the healthcare requirement at the different growth rates of medical expenses, even when higher discount rates such as 5%. For example, at the benchmark long-term interest rate

of average rate of 4%, the shortfall from the decreed sum increases from 34% to 54% and then to 75% as medical growth increases from 3% to 4% and then to 5%.

Turning to the elasticity of *PVHE* with respect to the growth rate of medical expenses and to the mean interest rates, we find relative uniformity in the magnitude for both the male and female elderly under the CIR and CYC models.[26] For example, a 1% increase in medical expenditure under the benchmark scenario leads to a 0.74% increase in *PVHE* for the female elderly in 3-room and 0.60% in 5-room. The corresponding increase for the male elderly in 3-room and 5-room housing are 0.61% and 0.58% respectively. A 1% increase in the long-term interest rate under the benchmark scenario leads to a 0.70% decrease in *PVHE* for the female elderly in 3-room and 0.50% in 5-room; and a corresponding 0.61% decrease for the male elderly in 3-room and 0.50% in 5-room. Hence, for both gender the *PVHE* is slightly more elastic to growth rates of healthcare expenses than to long-term interest rates charged to MSA.

Next, we shall explore the policy implications arising from a positive relationship between *PVHE* and medical growth rate, and a negative relationship between *PVHE* and the interest rate earned on MSA. Given the decreed minimum sum set at $25,000, it is interesting to know how policy makers would respond to a 1% increase in the medical growth rate. There are two options available: either raising the minimum sum amount without increasing the interest rate earned on MSA or increasing the interest rate earned on the MSA without raising the decreed minimum sum.

[26] It can be easily shown that the *PVHE* increases with an increase in the medical cost growth rate and decreases with an increase in the interest rate charged to MSA. The latter is due to the time value of money.

In what follows, we consider the impact of increasing the interest rate earned on MSA without raising the decreed minimum sum. If θ_i is defined as the percentage change in the interest rate charged to MSA and θ_g is the percentage change in healthcare growth rate, then the following relationship holds for a given level of *PVHE*,

$$\theta_i = (\eta_{h,\,g} / \eta_{h,\,i}) \text{ x } \theta_g \qquad (5)$$

where $\eta_{h,\,g}$ is the elasticity of *PVHE* with respect to the growth rate of healthcare expenses and $\eta_{h\,i}$ is the elasticity of *PVHE* with respect to interest rate charged to MSA. Values of θ_i could be computed from our simulated *PVHE*. For illustrative purposes, the estimated values of θ_i under the benchmark scenario for the female and male elderly in 3-room are 1.06 and 1.0, respectively. This implies from equation (5) that for those elderly in 3-room, with a 1% increase in medical growth rate, the interest rate earned on MSA for the female and male elderly should be increased by 1.06% and 1.0%, respectively. Similarly, the estimated values of θ_i for the female and male elderly in 5-room are 1.20 and 1.16, respectively. This indicates that for a 1% increase in the medical growth rate, the interest rate earned on MSA for the female and male elderly should be increased by 1.20% and 1.16%, respectively. Such values of θ_i may serve as useful guides to raise the interest rate charged on the MSA in order to ensure adequate savings to finance post-retirement medical expenses without raising the decreed minimum sum. This policy option seems to be vital when the balance in the MSA is alarmingly below the decreed minimum sum. As shown in Table 9, the average Medisave balance stands at only

$13,769 as at 31 December 2000. Hence, it may provide support for the case of raising the interest rate charged on the MSA.

== Insert Table 9 ===

5. Concluding remarks

We have assessed the adequacy of using MSA to finance healthcare expenditure for the representative Singaporean male and female over their post-retirement period. We estimate the present value of lifetime healthcare expenses of the elderly upon retirement at age 62 by gender and by income types which are stratified according to the dwelling types. Our approach involves calibrating the healthcare expenses of the elderly, constructing cohort mortality rates from abridged life tables and employing three different interest rate models to discount the future cash flows. The estimated healthcare expenses under different scenarios are then compared with the government decreed minimum sum in the medical savings accounts.

Our simulation results show that under the benchmark scenario, the decreed minimum balance of $25,000 in the individual Medisave account would be adequate for both the less well-off male and female elderly in the 3-room public housing at 4% medical cost growth and at 4% or higher discount rates. It is also adequate for the better-off male elderly in the bigger 4 and 5-room flats, but not so for the female elderly. The inadequacy for the female elderly is in the range of 34% to 75% of the decreed sum of $25,000 and it becomes more severe when medical expense grows at higher rates.

Our findings are consistent with the fact that Medisave has contributed to the framework of a cultural rhetoric of personal responsibility for health care (see Barr 2001). Indeed, Pauly and Goodman (1995b), Massaro and Wong (1995), Eiff et al. (2002), Gratzer (2002) and others have commended on Singapore for attaining developed country's health indicators (life expectancy, infant mortality, etc.) at a fraction of the cost operating in most developed countries.[27] Aside from economic efficiency, patients have easy access to technology as bypass surgery and organ transplants, with minimal waiting time. And the income of physicians in Singapore is about the same in relation to average wages as physician income in Germany or the United States.

In order to keep the current decreed amount remain relatively unchanged at the decreed level of $25,000, our study suggests that for 1% increase in the growth rate of medical expenses, the interest rate earned on MSA ought to be increased to 1.06% and 1.0% respectively for the female and male elderly in 3-room flats; and to 1.20% and 1.16% for those in 4- and 5-room flats, respectively. However, the reality may be less rosy. According to the Ministry of Health in Singapore, only 56% of Singaporeans who reached age 55 in 2000 year have Medisave savings that were at least the Medisave minimum sum (which was decreed at $19,000). Table 9 shows that the average of Medisave balances of these Singaporeans were about $13,769. It also indicates that for those aged 60 to 64 in 2000, the average balance is 32% short of the decreed amount. It increases as we move up the age group. For example, the shortfall for those aged 60 to

[27] Singapore's healthcare costs are around 3% of GDP, compared to 9.3% for Canada and 10.5% for Germany. However, there is a perception that great care must be exercised in attributing Singapore's low expenditure on health care to the MSA program. (Barr, 2001; Pauly, 2001)

64 is 53% and that for 70+ is 77%. Hence the impact of using MSA as a healthcare financing scheme should be evaluated within the entire health care financing framework.

The image of a three-legged stool has often been used to represent support in retirement (Cutler 1996). A similar three-legged stool may be used to represent the alternative means of healthcare financing. They include a compulsory individual medical savings, a high-deductible medical insurance for catastrophic illnesses, and government insurance and assistance. In order to strengthen the leg of medical savings account, the Singapore government has introduced a series of Medisave top-ups for the elderly since 1995. The amount of top-ups increases with the age of the elderly. In 2001, to help Singaporeans build up their savings faster, the government pegged the interest rate of Medisave account to that of the special account. It was estimated by the government that a typical Medisave Account holder between age 40 and 55 would earn about an additional of $8,100 as interest income if the Medisave interest rate is increased by 1.5% per annum. However, there is a limit to increasing the amount in the medical savings accounts. The balance in the account depends on the economic health, particularly on full employment which enables Singaporeans to make sufficient contributions to the CPF. This warrants re-looking at alternatives that would help to strengthen the leg of medical savings account or even the other legs.[28] For instance, the government could lengthen the leg of medical insurance by raising the claim limits for Medishield. The Singapore government has also attempted to strengthen the disability care insurance by introducing

[28] Chia and Lim (2003) use a computable general equilibrium model to assess the various mechanisms to strengthen the medical savings account in the event of medical inflation. The mechanisms considered include tops up in medical saving account and increasing interest on Medisave account.

Eldershield in September 2002. This insurance scheme was designed to help people who become severely disabled.[29] In order to further ensure affordability of medical cares, the MOH has recently made available more class C beds (open wards with minimum frills and 80% government subsidies) to lower income Singaporeans.[30]

This paper has confined its analysis to assessing the adequacy of the decreed amount in MSA for the Singaporean elderly to finance healthcare expenses in their post-retirement. However, a more comprehensive evaluation should be conducted within the whole financing structure in the accumulation process of the forced savings in MSA, together with periodic fine tunings to ensure smooth functioning of the system. In addition, wider coverage of longitudinal surveys should be conducted to trace relationships between health spending and the demographic and health sector-related variables among different age groups of the elderly. These are left for future studies.

[29] Eldershield was touted as one of the key components of 3M plus 2E healthcare financing formula (2Es include the Eldershield and Eldercare). But responses to these schemes have been disappointing.
[30] In September 2001, the Singapore General Hospital increased the number of Class C beds by 74% and the National University Hospital increased the number by 170%.

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Table 1: Contributions to the Central Provident Fund, January 2002

Employee Age (years)	Contribution by Employer (% of wage)	Contribution by Employee (% of wage)	Total Contribution (% of wage)	Credited to		
				Ordinary Account %	Special Account %	Medisave Account %
35 & below	16	20	36	26	4	6
Above 35 – 45	16	20	36	23	6	7
Above 45 –55	16	20	36	22	6	8
Above 55 – 60	6	12.5	18.5	10.5	0	8
Above 60 – 65	3.5	7.5	11	2.5	0	8.5

Source: Singapore CPF website: http://www.gov.sg/cpf

Table 2: Provision of health care financing for the aged by gender (in percentage)

Type of Provision	Total	Men	Female
Children's Medisave	55.0	43.8	65.0
Spouse's Medisave	2.0	0.6	3.2
Own Medisave	17.9	30.1	6.9
Own savings	12.0	13.1	11.1
Other provisions	5.2	5.1	5.3
No provision	7.9	7.3	8.5

Source: Ministry of Health et al. (1996)

Table 3: Profile of households by housing types in Singapore

	Public Housing						
	1-room	2-room	3-room	4-room	5-room	Execu-tive	Private Housing
Average Floor Area (sq ft)	330	450	550-900	750-1100	1200-1500	1500-1900	1300-2000
Mean Monthly Household Income ($)	1336	1691	2808	3546	5061	6606	13840
Median Monthly Household Income ($)	1000	1300	2250	2979	4500	6000	n.a.

Source: Singapore, Housing Development Board (2000), Household Expenditure Survey 1997/98 and HDB website.
Note: 1 sq. m. = 10.764 sq. ft.

Table 4: Annual medical expenditure of elderly in 1-, 2- and 3-room public housing

Age	Male		Female	
62-65	$601	(78)	$730	(83)
66-70	$813	(78)	$601	(74)
71-75	$1392	(48)	$716	(98)
76-80	$1592	(36)	$1440	(83)
81-85	$1789	(76)	$903	(111)
86-90	$836	(39)	$911	(47)
91+	$954	(12)	$1903	(16)

Source: Transition in Health, Wealth and Welfare of Elderly Singaporeans: 1995-1999, unpublished survey data.
Note: The figures in parenthesis indicate the sample size. The data is made available by A. Chan (2001), Department of Sociology at the National University of Singapore, who coordinated with the Ministry of Community Development to conduct a longitudinal study of the transition in health, wealth and welfare of the elderly Singaporeans. The first panel survey is conducted in 1995 with 4750 individuals aged 55 and above. The follow-up survey conducted in 1999 includes about 42% of the original sample size.

Table 5: Annual medical expenditure of elderly in 4- and 5-room public housing

Age	Male		Female	
62-65	$883	(80)	$1925	(81)
66-70	$714	(75)	$1537	(87)
71-75	$1824	(39)	$1159	(84)
76-80	$1130	(29)	$1327	(58)
81-85	$1263	(73)	$1458	(79)
86-90	$1108	(28)	$1410	(41)
91+	$1505	(5)	$1750	(16)

Source: Transition in Health, Wealth and Welfare of Elderly Singaporeans: 1995-1999, unpublished survey data by Chan (2001).
Note: The figures in parenthesis indicate the sample size.

Table 6: Values of parameters for different scenarios

(i)	Healthcare expenses Growth rate of medical expenditure (m_g) = 4 % per annum. Other values are 3% and 5%.
(ii)	Cox-Ingersoll-Ross model of stochastic interest rates: Initial interest rate = 2%, 3%, and 4% Average interest rate (r_a) = 2%, 3%, 4% and 5% Values of mean reversion (θ) = 0.2, 0.3 and 0.4 Value of the interest rate volatility parameter (β) = 0.01, 0.02 and 0.03

Table 7:
Comparison of *PVHE* for the elderly in 3-room under different interest rate models

Scenario	Model	Female	Male
[a] 3% medical growth rate			
$r_a = 2\%$	FYC	\$21034	\$21066
	CIR	\$30116	\$28739
	CYC	\$29346	\$27955
$r_a = 3\%$	CIR	\$24135	\$23839
	CYC	\$24676	\$24198
$r_a = 4\%$	CIR	\$20889	\$21026
	CYC	\$20981	\$21095
$r_a = 5\%$	CIR	\$17431	\$17960
	CYC	\$18030	\$18514
[b] 4% medical growth rate			
$r_a = 2\%$	FYC	\$24744	\$24170
	CIR	\$36110	\$33365
	CYC	\$35175	\$32438
$r_a = 3\%$	CIR	\$28600	\$27484
	CYC	\$29295	\$27915
$r_a = 4\%$	CIR	\$24557	\$24110
	CYC	\$24676	\$24198
$r_a = 5\%$	CIR	\$20272	\$20460
	CYC	\$21013	\$21122
[c] 5% medical growth rate			
$r_a = 2\%$	FYC	\$29334	\$27849
	CIR	\$43626	\$38903
	CYC	\$42486	\$37805
$r_a = 3\%$	CIR	\$34151	\$31822
	CYC	\$35049	\$32343
$r_a = 4\%$	CIR	\$29093	\$27765
	CYC	\$29246	\$27876
$r_a = 5\%$	CIR	\$23757	\$23406
	CYC	\$24676	\$24198

Notes:
PVHE for the female and male elderly are computed using three different interest rate models. CIR represents the yield curve generated by the Cox, Ingersoll and Ross model with 10,000 replications; CYC is the flat yield curve at 2%, 3%, 4% and 5% respectively; and FYC is the fixed yield curve based on the mean spot rates of government bonds with various durations.

Table 8:
Comparison of *PVHE* for the elderly in 5-room under different interest rate models

Scenario	Model	Female	Male
[a] 3% medical growth rate			
$r_a = 2\%$	FYC	\$33857	\$21616
	CIR	\$45634	\$29202
	CYC	\$44448	\$28443
$r_a = 3\%$	CIR	\$39124	\$25158
	CYC	\$38523	\$24727
$r_a = 4\%$	CIR	\$33554	\$21593
	CYC	\$33753	\$21673
$r_a = 5\%$	CIR	\$29631	\$18961
	CYC	\$29877	\$19143
[b] 4% medical growth rate			
$r_a = 2\%$	FYC	\$38641	\$24667
	CIR	\$53183	\$33823
	CYC	\$51723	\$32906
$r_a = 3\%$	CIR	\$45095	\$28906
	CYC	\$44385	\$28404
$r_a = 4\%$	CIR	\$38245	\$24614
	CYC	\$38523	\$24727
$r_a = 5\%$	CIR	\$33505	\$21489
	CYC	\$33795	\$21700
[c] 5% medical growth rate			
$r_a = 2\%$	FYC	\$44461	\$28301
	CIR	\$62509	\$39403
	CYC	\$60709	\$38291
$r_a = 3\%$	CIR	\$52410	\$33399
	CYC	\$51568	\$32811
$r_a = 4\%$	CIR	\$43942	\$28209
	CYC	\$44323	\$28365
$r_a = 5\%$	CIR	\$38179	\$24482
	CYC	\$38522	\$24727

Notes:
PVHE for the female and male elderly are computed using three different interest rate models. CIR represents the yield curve generated by the Cox, Ingersoll and Ross model with 10,000 replications; CYC is the flat yield curve at 2%, 3%, 4% and 5% respectively; and FYC is the fixed yield curve based on the mean spot rates of government bonds with various durations.

Table 9:
Number of Medisave Accounts and Balance by Age as at 31 December 2000

Age group	Active members		Inactive members		Total
	No. of accounts	Average balance	No. of accounts	Average balance	Members
Below 25	94,256	$ 2,901	61,359	$ 615	155,615
25 - 34	387,832	$ 10,497	140,032	$ 4,689	527,864
35 - 44	372,290	$ 16,996	243,722	$ 7,074	616,012
45 - 54	249,079	$ 17,812	224,068	$ 6,528	473,147
55 - 59	54,454	$ 15,942	92,040	$ 5,186	146,494
60 - 64	21,771	$ 14,374	65,039	$ 4,872	86,810
65 - 69	14,012	$ 12,461	74,338	$ 4,018	88,350
70 +	9,053	$ 10,689	152,486	$ 2,280	161,539
Total	1,202,747	$ 13,769	1,053,084	$ 5,053	2,255,831

Source: Singapore, Ministry of Health Press Release: Stretching your Medisave Dollar. August 2001.

Appendix 1: Comparison of classes of hospital wards in Singapore

Ward class	Differences					Subsidy rate
	Air-con	Attached toilet/ shower	TV & phone	Choice of doctor	No. of beds per room	
A	Y	Y	Y	Y	1-2	0%
B1	Y	Y	Y	Y	4	20%
B2+	Y	Y	N	N	5	50%
B2	N	N	N	N	6	65%
C	N	N	N	N	> 6*	80%

Notes: *means more than 6 beds in the open ward. Y stands for "available" and N stands for "not available".

Source: Ministry of Health website