

SM Bonds – a New Product for Managing Longevity Risk

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Features of New Product (SM bonds)

- ▶ Govt guaranteed retirement annuities for individuals
- ▶ No longevity exposure for government!
- ▶ No middlemen/ticket clippers/fees (actuaries, insurance co's, finance professionals etc)
- ▶ No record keeping bureaucracy (implemented on "smart" blockchain)
- ▶ YOU manage.
- ▶ Anonymous, 100% secure transactions, peer2peer insurance
- ▶ Instant longevity market and pricing!

Longevity Risks

- ▶ Individuals
 - ▶ Will my retirement savings be enough?
- ▶ Governments/taxpayers
 - ▶ the “ageing population” problem
 - ▶ unaffordable burden on future governments/taxpayers
- ▶ Markets
 - ▶ Can markets effectively price “longevity” (Apparently not)
 - ▶ Insurers and pension funds needs better methods for hedging longevity risk

We need products that incentivise annuitisation

- ▶ Consequences of present system
 - ▶ Those who live longer than their savings – government pays
 - ▶ Those who die before expending their savings – heirs collect
- ▶ In effect there is a transfer from governments to heirs:
- ▶ A lifetime annuity would avoid this

Why don't more people annuitise?

In practice, people don't buy annuities. Why?

- ▶ High cost of lifetime annuities
- ▶ Bequest motives
- ▶ Liquidity needs
- ▶ Adverse selection
- ▶ Provider insolvency risk
- ▶ “Crowding out” by Pension
- ▶ Behavioural issues/Financial literacy

Can government intervention solve the problem?

- ▶ Social security system
- ▶ Government longevity bonds
- ▶ Exposes government to longevity risk
- ▶ Political pressure to underfund. Leading to intergenerational transfers (kicking the can down the road)
- ▶ Lazy, Expensive, and (often) self serving answer:

WE NEED MORE RULES AND REGULATIONS

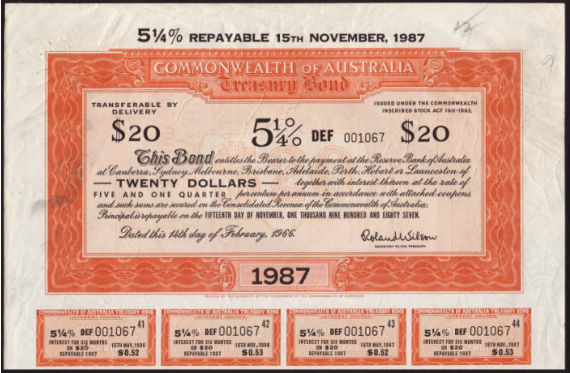
- ▶ SM bonds avoid this lazy, expensive answer

The SM Bond public/private partnership benefits

- ▶ For individuals:
 - ▶ Govt guaranteed defined benefit pension
- ▶ For governments:
 - ▶ NO longevity exposure
- ▶ For markets/private sector
 - ▶ Liquid longevity market

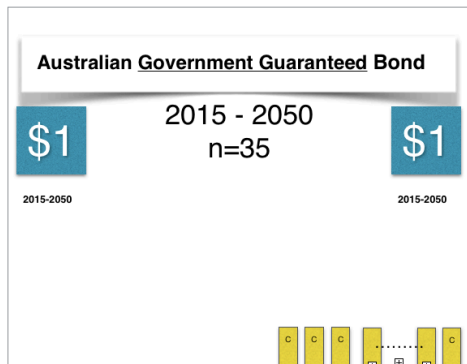
Government bond

- ▶ Traditional government bond
 - ▶ $n = 21$ yr \$20 bond issued 1966
 - ▶ Coupon $c = 5.25\%$ p.a.



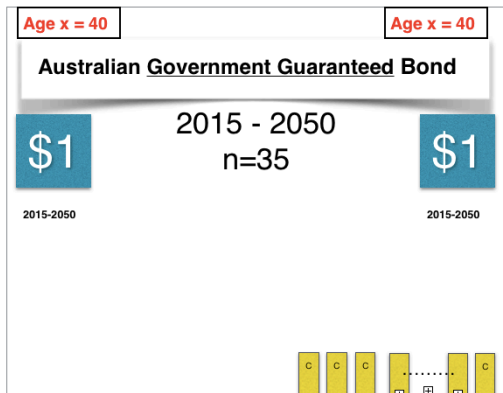
SM bonds – start with a government guaranteed bond

- ▶ Suppose face value \$1
term $n = 35$ and
coupon c
- ▶ Govt Guaranteed to
pay out \$1 in year
 $2015 + 35 = 2050$
- ▶ Price = $ca_{\overline{n}|r} + e^{-rn}$,
($r =$ risk free rate).
- ▶ Price ≈ 1 if $c \approx r$
- ▶ Call this a 2015 bond
(term n left implicit)



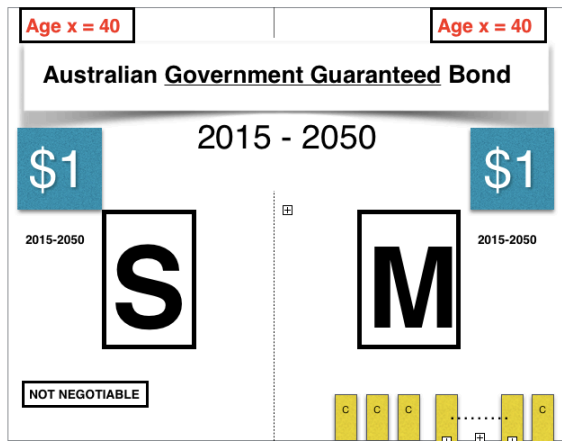
SM bonds – add age x (eg 40)

- ▶ This bond can **ONLY** be purchased (originated) by those aged $x = 40$ in 2015
- ▶ This is a 2015/40 bond
- ▶ Bonds will be available for ages (say) $x = 30, \dots, 64$
- ▶ 2015/30, \dots , 2015/64



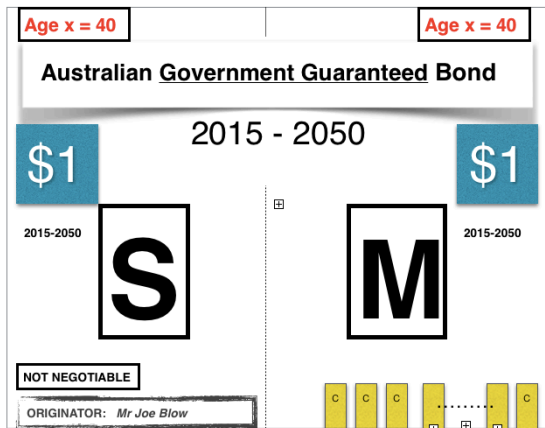
SM bond – Label S (Not Negotiable), and M

- ▶ Write S and “NOT NEGOTIABLE” on left
- ▶ Write M on right
- ▶ We now have a 2015/40 SM bond



SM bond – suppose Joe Blow buys an SM bond

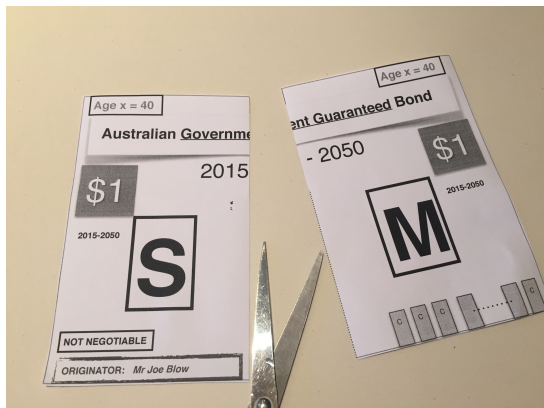
- ▶ Joe must be 40 years old
- ▶ If $c = r$ Joe pays $\approx \$1$
- ▶ Write Joe's name on S part
- ▶ Joe is the ORIGINATOR of a 2015/40 SM bond



SM bond – Joe Blow gets out scissors and cuts

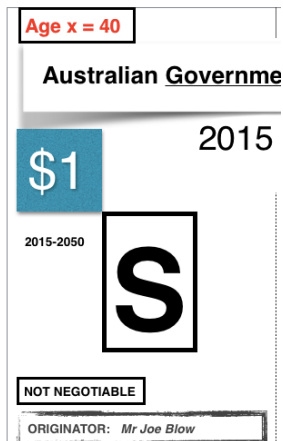
We now have

- ▶ 2015/40 **S** bond
(Joe's – not negotiable)
- ▶ 2015/40 **M** bond
(anonymous)
- ▶ The term ($n = 35$) on each bond is implicit



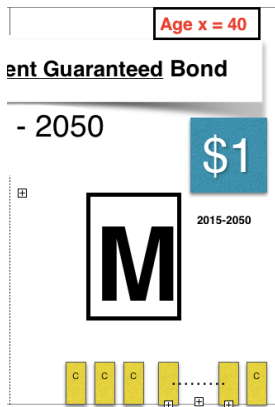
S (survival) bond

- ▶ MUST be retained by the originator **Joe** (*not negotiable*)
- ▶ Denoted 2015/40 **S** (Joe Blow)
- ▶ Pays (guaranteed) \$1 to originator **Joe** if he/she survives to redemption in 2015 (age $x + n = 75$)
- ▶ If originator **Joe** dies before $n = 35$ years, \$1 is paid, at redemption (2050), into the 2015/40 “mortality pool”



M (mortality) bond

- ▶ Joe can sell at any time
- ▶ Anyone can buy and then trade
- ▶ Denoted 2015/40 M
- ▶ Guaranteed payouts:
 - ▶ annual coupon of c
 - ▶ 2050: pro-rata share (q) of 2015/40 mortality pool
 - ▶ q : proportion of deaths amongst 2015/40 originators, prior to 2050
- ▶ q unknown before 2050 but becomes more certain as 2050 approaches



Price of M bond t years after origination

- ▶ $M_{[x]+t} = ca_{\overline{n-t}|} + e^{-(r+\delta)(n-t)}\hat{q}$.
 - ▶ c coupon, $a_{\overline{n-t}|}$ annuity certain for $n - t$ years
 - ▶ \hat{q} is market estimate of q , r is “risk free” rate
 - ▶ δ is extra discounting for “mortality risk” $\hat{q} \neq q$
 - ▶ varies with t , $n - t$, etc.
- ▶ Who will buy M bonds?
 - ▶ Standardised contract/no default risk
 - ▶ Based on diversified risk pool (esp. if tax incentivisation)
 - ▶ New (uncorrelated) asset class
 - ▶ Arbitrage across different year/age bonds
 - ▶ SM originator can retain M bond if price “too low”
- ▶ Compare with current “longevity” market
 - ▶ most trades over the counter
 - ▶ illiquid/non standard/defaultable contracts
 - ▶ adverse selection

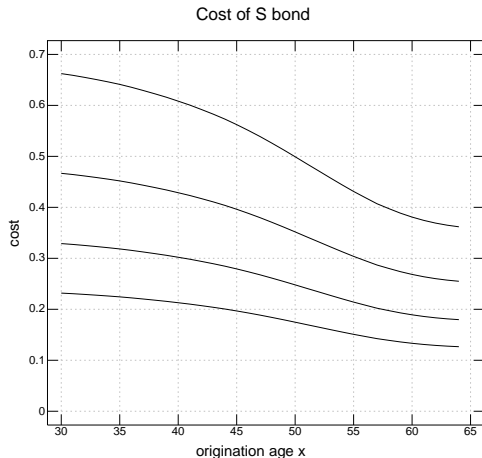
SM bond - who gets what?

- ▶ Government – no uncertainty
 - ▶ Cash flows are identical to any conventional govt bond
 - ▶ NO exposure to longevity risk
- ▶ M bond purchaser at time t – some uncertainty
 - ▶ Cost $M_{[x]+t}$
 - ▶ Receives annual coupon c plus risk pool share q at time n
 - ▶ payoff q depends on age x cohort mortality
- ▶ S bond holder Joe Blow – life/death (no?) uncertainty
 - ▶ Joe receives 1 IF alive at age $x + n$, 0 otherwise
 - ▶ Cost of originating SM bond: $ca_{\overline{n}|} + e^{-rn}$
 - ▶ Sale price of M bond: $M_{[x]} = ca_{\overline{n}|} + e^{-(r+\delta)n}\hat{q}_x$
 - ▶ Net cost of S bond
$$e^{-rn} - e^{-(r+\delta)n}\hat{q}_x = e^{-rn} \left\{ \hat{p}_x + \frac{\hat{q}_x(1 - e^{-\delta n})}{\delta} \right\}$$
 - ▶ xxx $\approx n\delta\hat{q}_x \approx 0.1\hat{q}_x = \text{"risk charge"}$
 - ▶ $\hat{p}_x + n\delta\hat{q}_x \approx 0.1 + 0.9\hat{p}_x$

Individual retirement planning 101

Joe Blow buys 1 S bond each year from age 30, ..., 64

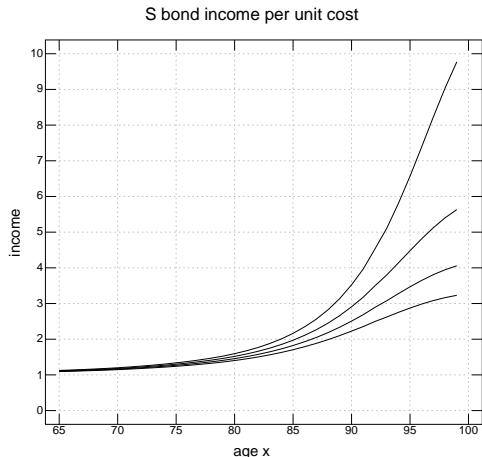
- ▶ Results in govt guaranteed annuity of \$1 for ages 65, ..., 99
- ▶ S cost at age x is approx $e^{-rn}(0.1 + 0.9\hat{p}_x)$
- ▶ S cost decreases with age x
- ▶ Figure displays S cost at each age x
 - ▶ $r = 1\%, 2\%, 3\%, 4\%$
 - ▶ $\delta = 0.25\%$



Individual retirement planning 102

Joe spends \$1 on S bonds each year from age 30, ..., 64

- ▶ $1/\{e^{-rn}(0.1 + 0.9\hat{p}_x)\}$ bonds at age x
- ▶ yields increasing annuity from age 65, ..., 99
- ▶ Figure displays S income
 - ▶ $r = 1\%, 2\%, 3\%, 4\%$
 - ▶ $\delta = 0.25\%$
- ▶ “Survivorship premium” ≈ 0 in early retirement years
- ▶ “Tail risk” annuity
 - ▶ Need savings to fund early years of retirement
 - ▶ Good for increasing health/aged care costs



Individual retirement planning 103

- ▶ Can mix and match the two strategies above to get any desired retirement income stream
- ▶ Inflation?
 - ▶ SM bonds based on inflation protected Govt bond
- ▶ Extra risk/return?
 - ▶ SM bonds based on Stock Market index:
 - ▶ coupon depends on stock market dividends
 - ▶ maturity value depends on stock market index
 - ▶ payouts are now “stock market guaranteed”
 - ▶ SM bonds based on long term corporate bonds
 - ▶ Corporations will not care if Joe cuts their bond in half
 - ▶ SM Long term infrastructure bonds – 0 coupon 1st 10 years
- ▶ Gaps and shortages in S bond origination?
 - ▶ filled with private sector products
 - ▶ private sector products priced off M bond prices

Implementing SM Bonds on the Blockchain

- ▶ Joe Blow sends $\$x$ to smart blockchain contract (using keys)
- ▶ In return "receives" x S tokens.
- ▶ corresponding x M tokens deposited into pool and all M tokens are sold off to whoever wants to buy. (keys needed!)
- ▶ Smart contract informed of "deaths"
 - ▶ Births/deaths registry: just another blockchain contract.
- ▶ Continual M market – (useful for pricing further products)
 - ▶ Smart contract is the "trading platform" for M tokens
- ▶ After n years smart contract sends $\$x$ to Joe Blow if alive
- ▶ If Joe Blow dead $\$x$ goes into pool and pool automatically divided (by smart contract) amongst the then M holders

No record-keeping infrastructure required. It's all "free"

Who will buy M bonds?

- ▶ Individual retirement savers
 - ▶ coupon can accumulate for a retirement balance
 - ▶ redemption amount q will provide extra risk/return
 - ▶ balanced holding of S and M will be relatively risk free
- ▶ Investment funds
 - ▶ A new (uncorrelated) asset class
- ▶ M market investors
 - ▶ M bonds potentially provide a new “uncorrelated” asset class
 - ▶ Life Insurance Co's etc who need to take a position in the longevity market
 - ▶ Arbitrageurs – easy to get into and out of longevity positions

Structure of M market

birth year	age				
	...	39	40	41	...
⋮	...				
1974	...	2013/39	2014/40	2015/41	...
1975	...	2014/39	2015/40	2016/41	...
1976	...	2015/39	2016/40	2017/41	...
⋮	...				

- ▶ Like runoff (die off?) triangle. Cells define a specific M bond
- ▶ “Die off” pattern in each row will be similar
- ▶ Cells “near” each other must have similar M prices

$$M_{[2015/40]+t} \approx M_{[2016/41]+t} \approx M_{[2016/40]+t} \approx \dots$$

- ▶ Lots of opportunity for arbitrage & pricing

SM bonds: Winners and Losers

Winners:

- ▶ Individuals – inexpensive government guaranteed annuities at "fair" prices. – no fees!
- ▶ Government/Taxpayers
 - ▶ No longevity risk
 - ▶ No bureaucracy
 - ▶ Increase in long term funding
- ▶ Those who live a long time (survivorship premium)
- ▶ Blockchain industry! Peer2peer insurance!

Losers:

- ▶ Those who die early (... do they really care about money?)
- ▶ Inheritors – less money to inherit
- ▶ Retirement funds – collect less money
- ▶ Those who feed at the "retirement trough" (no trough)
 - ▶ Financial industry
 - ▶ Gatekeepers/record keepers
 - ▶ Lawyers/regulators/actuaries?