



Gen Re | LifeHealth®

How much life insurance?

A utility based approach

Louis Rossouw

Why a different approach?

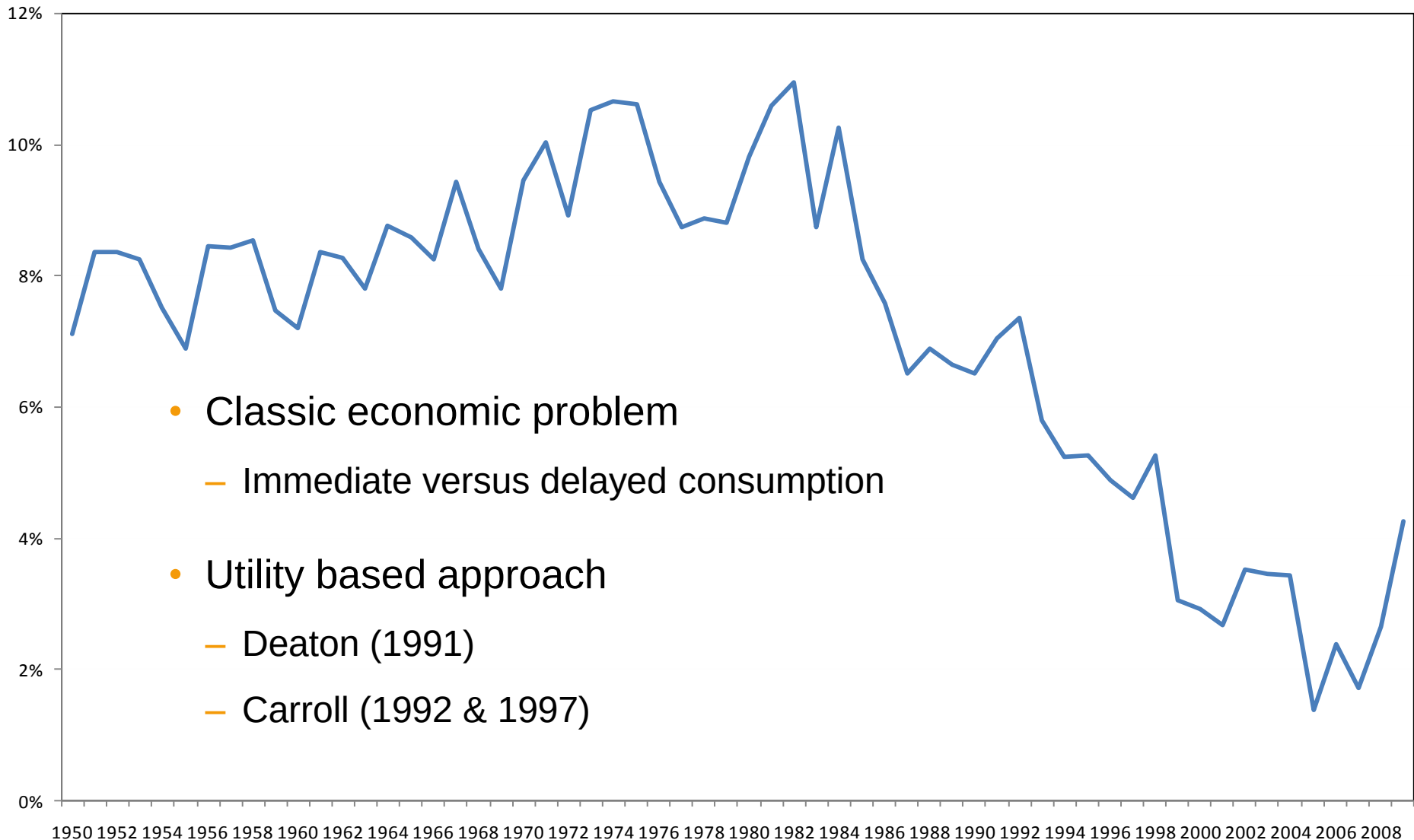
- Future needs of dependents
 - Spouse
 - Children
- Competing uses of limited resources?
 - Insurance
 - Saving for retirement
 - Consumption
- Which should take preference and when?
- “Best advice”
- Take account of current level of assets

What is the utility of insurance?

- Utility is a function of consumption
 - No consumption = no utility
 - Cannot consume life insurance yourself...
- For insurance to have utility we have to measure consumption
 - Model the dependants' consumption of insurance
 - Also they may delay consumption
- Decision making at a family level
 - Maximise expected utility to the family
 - Not the individual

Saving/Consumption

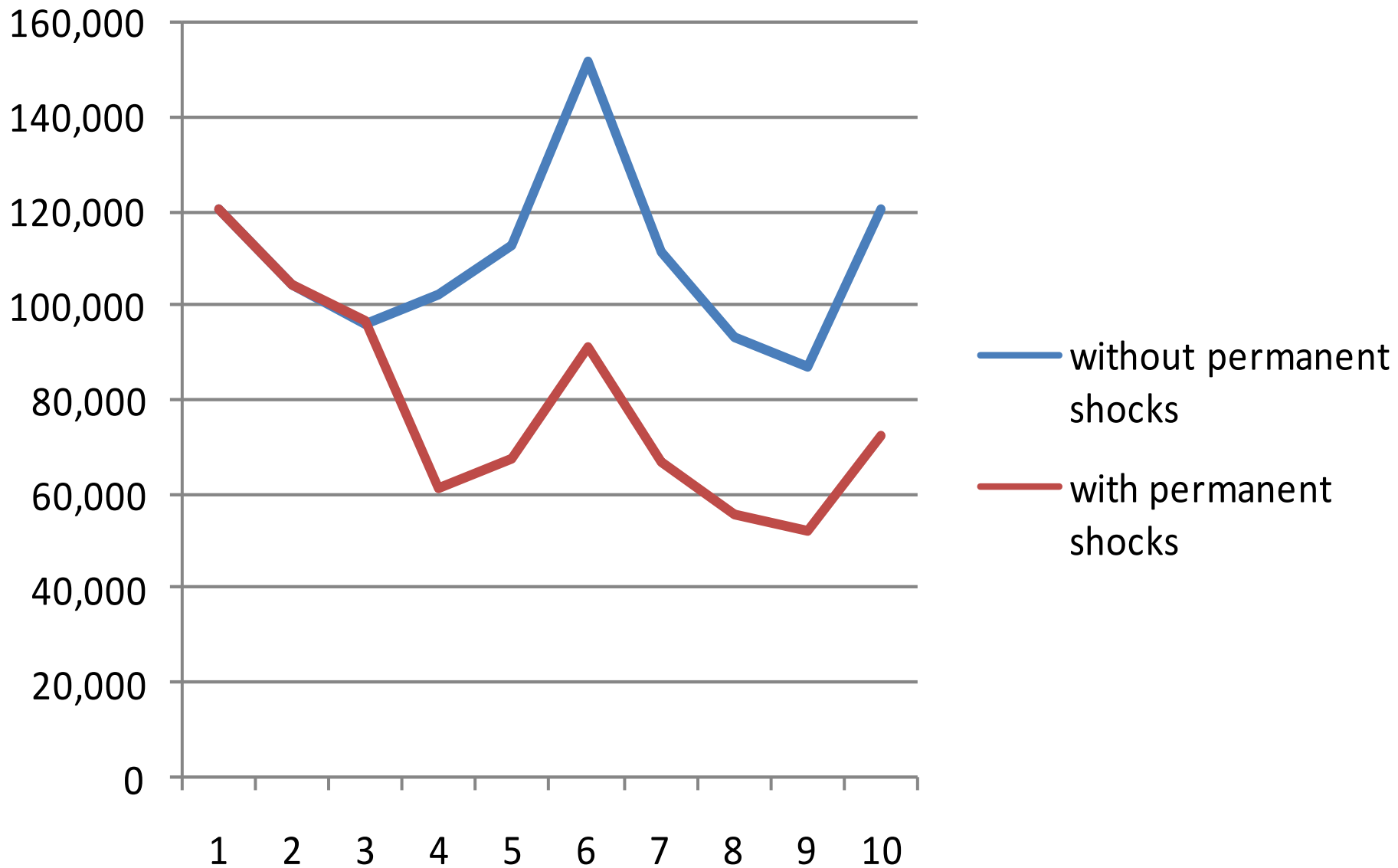
Savings Rate (% of disposable income)



Features of these models

- Model choice of savings or consumption over a lifetime
- Maximise the expected utility
- Unknown future income to retirement age
 - Random once-off shocks
 - Random permanent shock
- Unknown future lifetime
- Model the individual
- Results show that individual saves
- Protect against income shocks

Income Shocks



McCarthy (2005)

- Individual
- Savings vs. Consumption
- Asset choice
- Annuitisation
- Risks
 - Income shocks (permanent & temporary)
 - Correlation with returns on risky asset
 - Asset returns

Saving & Consumption & Insurance

- Adjustment to McCarthy's designs
- Added
 - Family (not just individual)
 - Insurance decision
- Removed
 - Asset choice
 - Permanent income shocks
 - Correlations of income shocks and asset returns
- Fixed annuity purchase at $\frac{2}{3}$ of assets at retirement

Model

- Model assets of family unit
 - 2 adults (principal & spouse)
 - Children (leave model at 21)
- Both adults can earn income
- All lives subject to random mortality (independent)
- Only principal can have insurance
- Random income shocks

Insurance

- 1-year term products
 - Insurance purchased at start of year
 - Claims paid at end of year
- Not modelling
 - Health status / selection / underwriting
 - Multi-year products
 - Joint life insurance products

Model

$$A_t - C_t - P_t = A'_t$$

$$A_{t+1} = A'_t \cdot R_t + \textit{income} + \textit{claims}$$

Utility

- Consumption is shared amongst remaining family members
- Each has utility function of the form

$$u^i(C_t^i) = \frac{(C_t^i)^{1-\gamma}}{1-\gamma}$$

- Total utility for the family as

$$u(\bar{L}_t, C_t) = \sum_i^{alive_t} \frac{(C_t^i)^{1-\gamma}}{1-\gamma}$$

- Consumption of each member is a fixed proportion of C_t
- Can differentiate and u and calculate the inverse

Problem specification

- We want to find all future P_t and C_t to maximise discounted expected future utility

$$E \left[\sum_{t=0}^T v^t u(\bar{L}_t, C_t) \right]$$

Solving

- One can show that

$$u'(\bar{L}_t, \hat{C}_t) = v \cdot E[R_t \cdot u'(\bar{L}_{t+1}, \hat{C}_{t+1})]$$

1) Solving C_T

- T is the last period
- T is when all $q = 1$
- No person is expected to survive
- $C_T = A_T$ for all A_T

2) Solving C_t given a solution for C_{t+1}

- If we have solved C_{t+1}
 - For all possible combinations of survival and A_{t+1}
- Can estimate the right hand side of this equation

$$u'(\bar{L}_t, \hat{C}_t) = v \cdot E[R_t \cdot u'(\bar{L}_{t+1}, \hat{C}_{t+1})]$$

- C_{t+1} is a function of A_{t+1}
- Solve by
 - Assuming various values for A'_t (assets after consumption)
 - Estimate RHS of equation
 - Then we can solve C_t and calculate corresponding A_t
- Repeat...

3) In practice

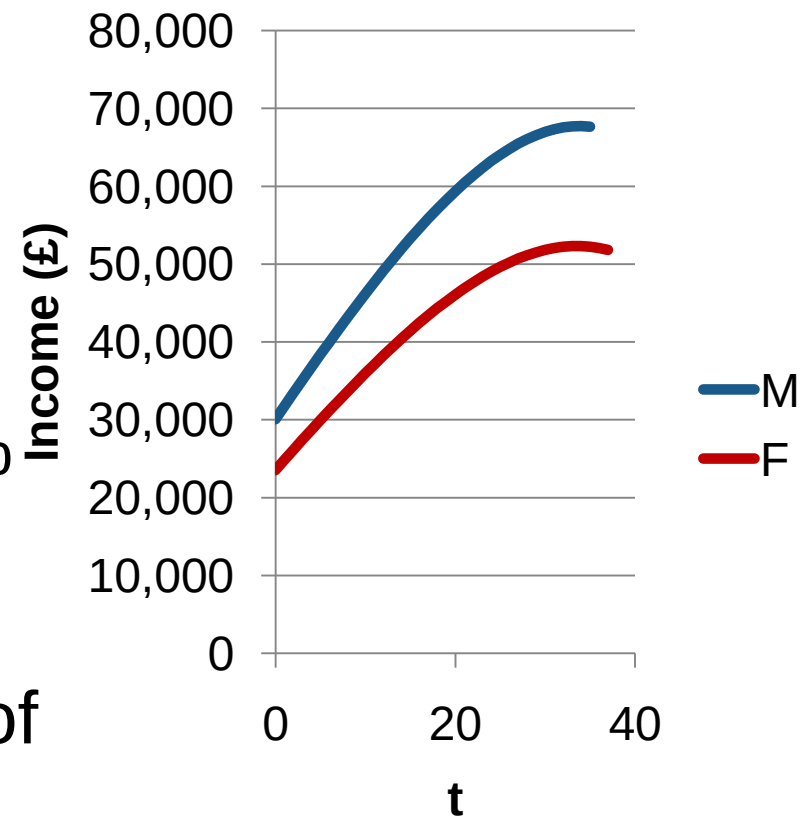
- “For all possible combinations of survival and A_{t+1} ”
 - Not possible as possibilities aren’t finite
 - Solve for selected points
 - We use interpolation with regard to “state variables”
 - A
 - Y
 - Need to take care of boundary conditions
- Discrete distributions for
 - Asset returns
 - Income shocks

Assumptions

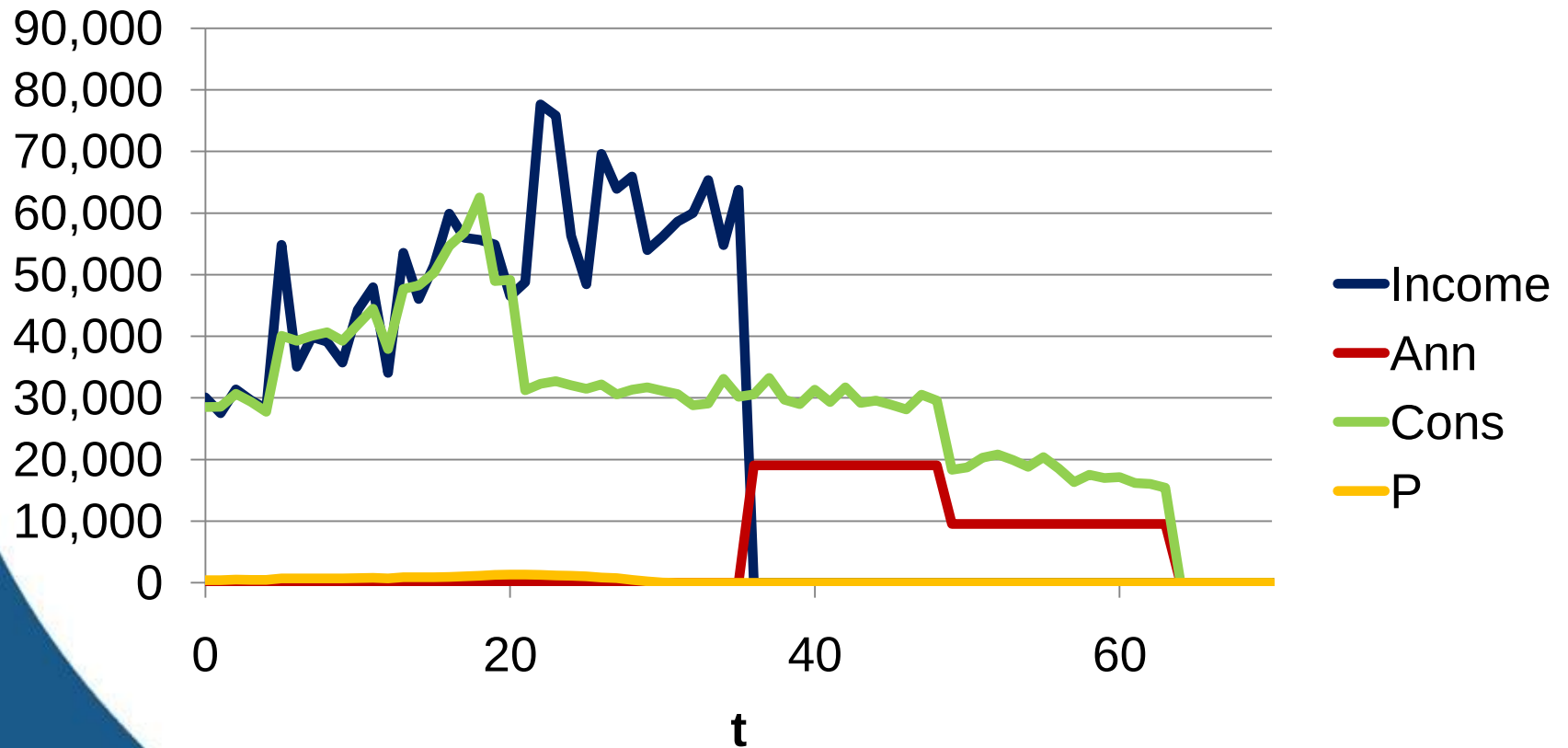
- Principal male aged 30, and female 28
- 2 children
- Consumption shared 30:30:20:20
- $\gamma = 3$
- Time preference discount of 3%
- Risk free returns of 2% (real return)
- Risky returns
 - Risk premium of 5%
 - Standard deviation of 20%.
 - 65% of assets in risky asset

Assumptions

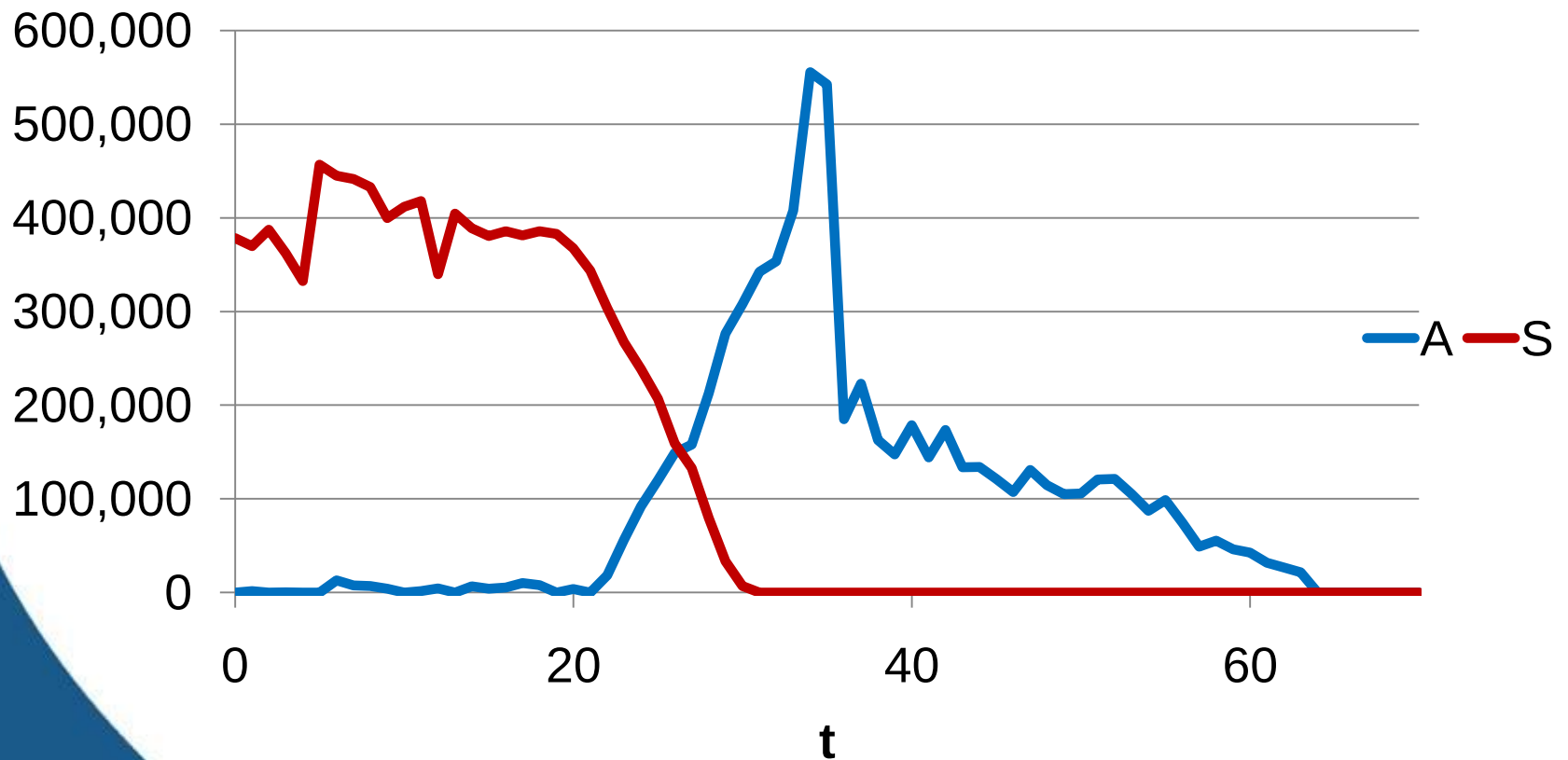
- Mortality = UK population mortality
- Ins. Margin = 20%
- Annuity margin 10%
- Income shock with standard deviation of 20%



Single simulation



Single simulation



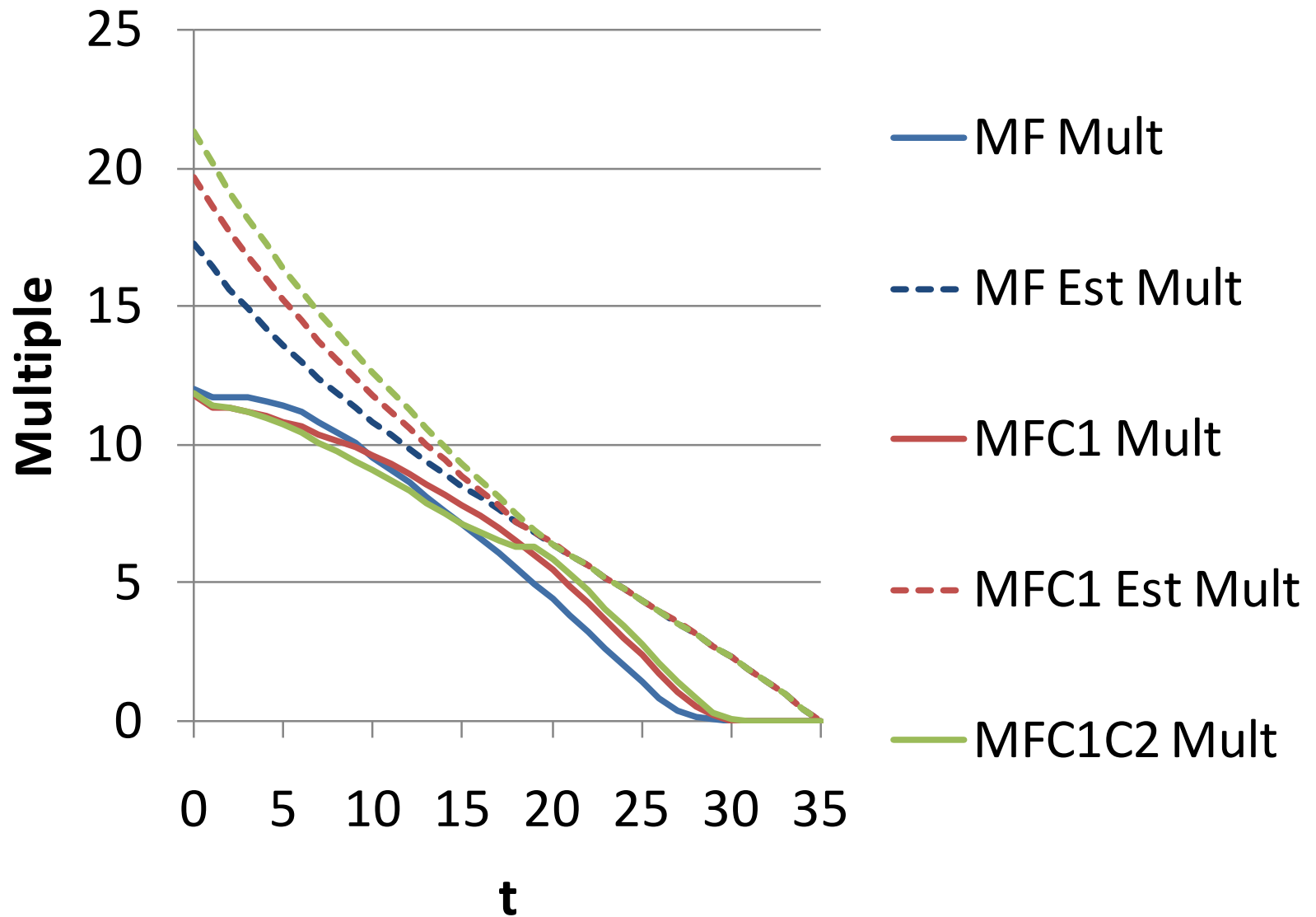
Results

- Compared with traditional method

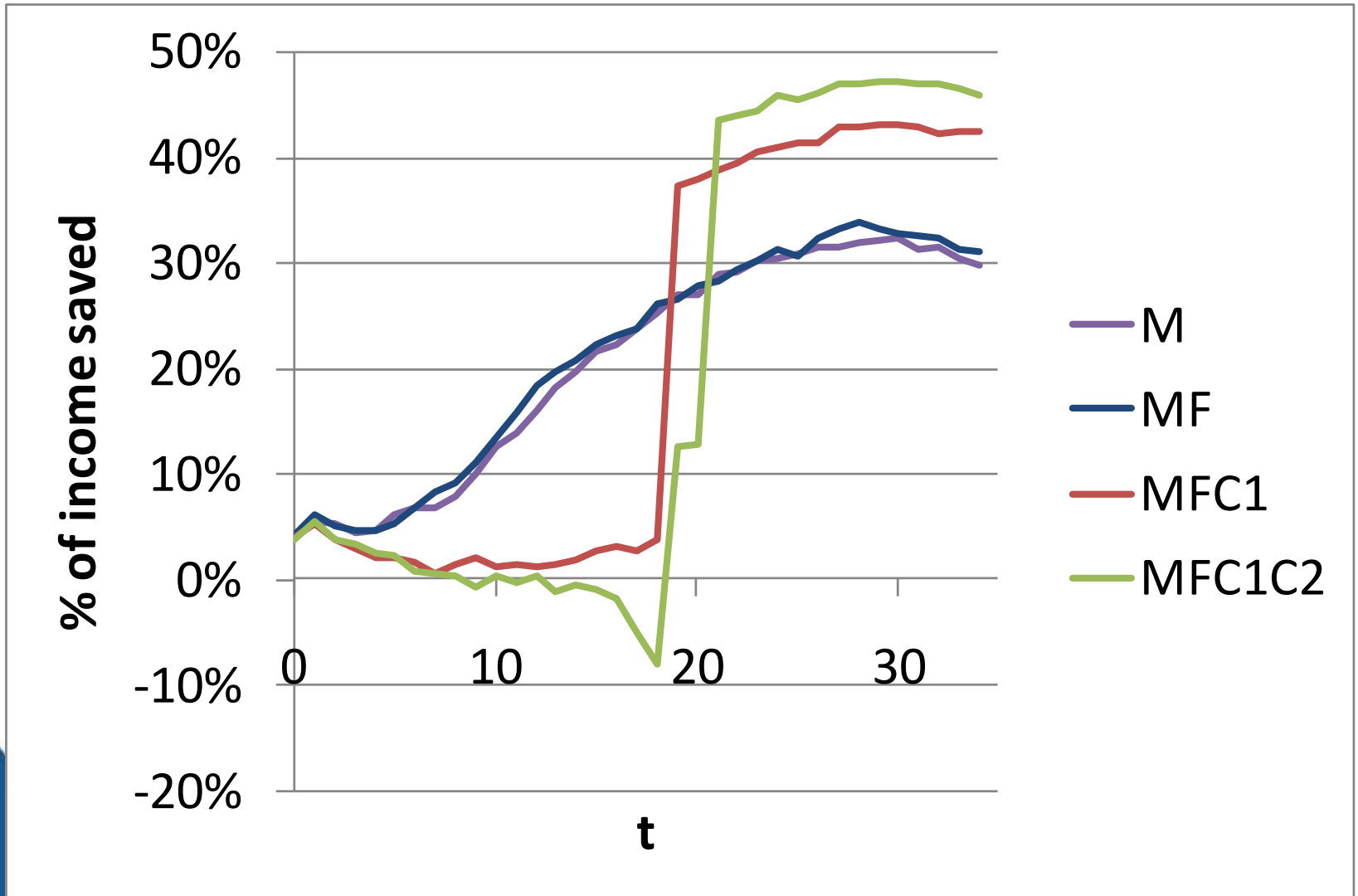
$$\sum_{t=0}^{retirement} (1 - share_t^{principal}) \cdot income_t \cdot v^t$$

- This is discounting
 - Discounting all income except the share that is due to principal
 - Adjusted share for when children “leave home”

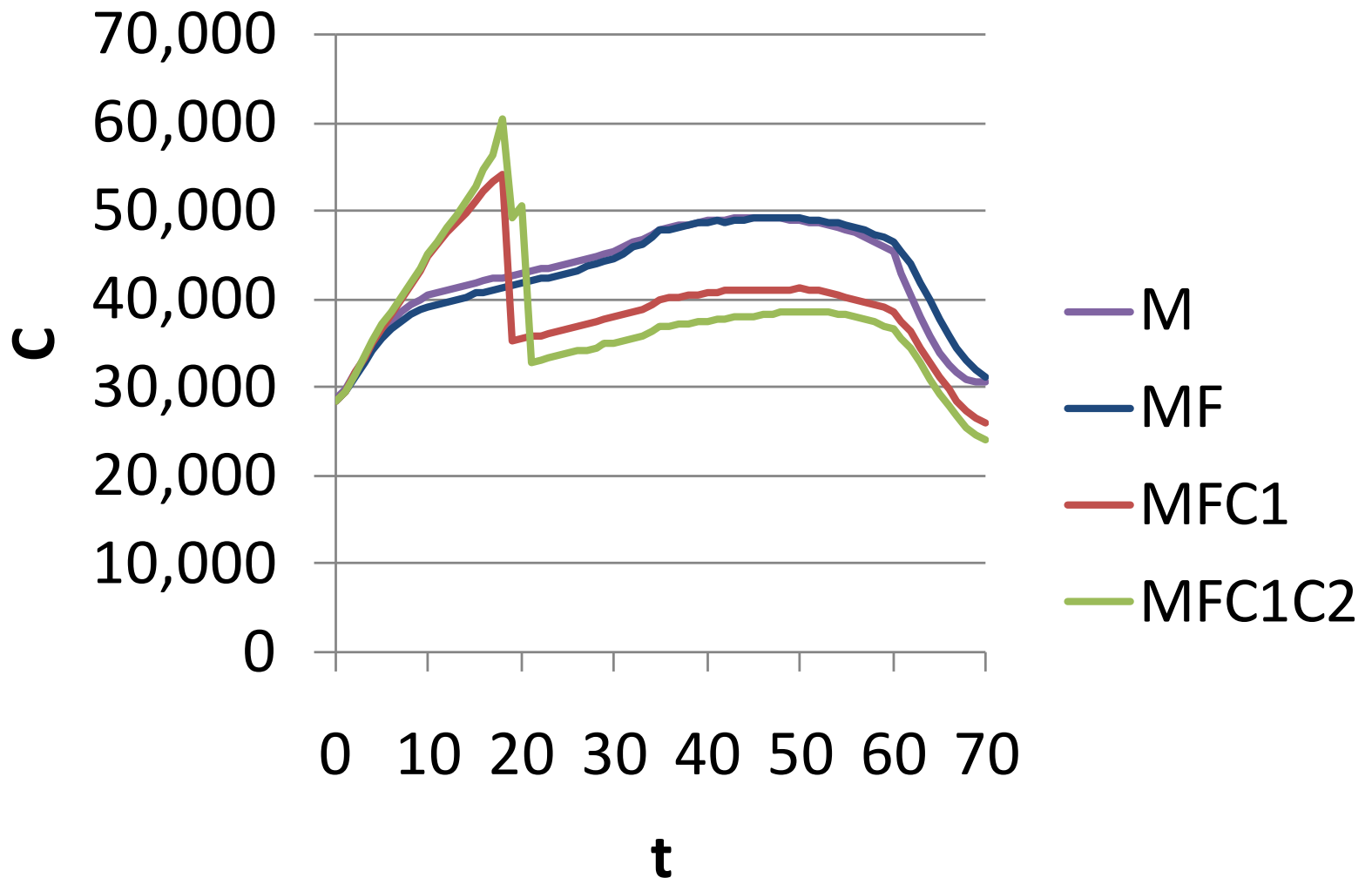
Cover multiples



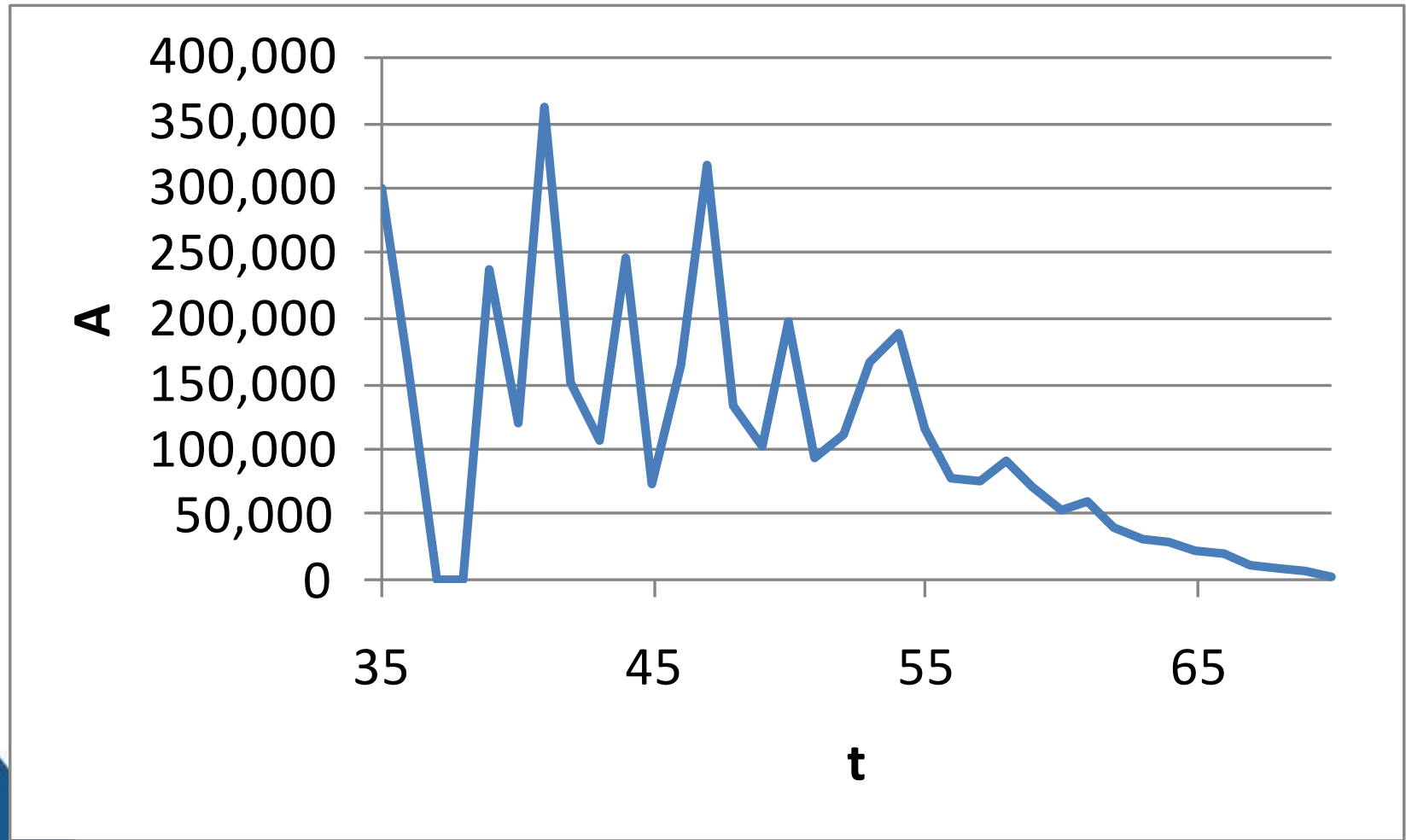
Savings



Consumption



“Unintended Bequests”



Demonstration

Some points to note

- Insurance not needed after retirement
- Less than discounted future need
- Reduced insurance with higher assets near retirement
- Empty nest means more savings
- Inheritance arises naturally
- Possible influences on product design?

Shortcomings & Further Work

- 30:30:20:20
- 1 year product
- Health status
- Permanent shocks to income
- No bequest motive
- Constant asset mix
- Choice of utility

What can I do with this model?

- Improve understanding the impact on insurance decisions of
 - Family structures and
 - Assets
- Design better life insurance & savings products
- Adjust of use as a tool in financial planning

Questions?

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Conclusions

- Model shows how demand may change
 - Over lifetime
 - For different families
- Framework to review decisions on insurance
- Better advice
- Better products