Understanding and Managing Healthy Life Expectancy

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Motivation

➢ Motivated by keynote speaker at 2016 Actuarial Research Conference

✓ Life expectancy will not increase indefinitely into the future

✓ Similar to a machine, the human body is expected to break down eventually despite medical advances, anti-aging drugs, etc.

➢ Since we cannot hope to live indefinitely, we want to maximize the quality of life over the limited time we have – hence the concept of Healthy Life Expectancy or HLE for short
Definition of HLE

- Defined as the expected future lifetime that one stays healthy
- Termination from a healthy state occurs by death or disability
- Disability uses a long term care definition which is inability to perform some of the activities of daily living
- The only recovery from disability is death
- In contrast, Unhealthy Life Expectancy (ULE) is the expected future lifetime that one stays unhealthy
- HLE + ULE = Life Expectancy (LE)
➢ Concept of healthy living is well established in the literature
  ✓ Articles generally determine HLE on a macro level using population statistics versus on an individual level
  ✓ None of the HLE models use actuarial probabilities of mortality and morbidity or clearly spell out their calculations

➢ The Goldenson Center research on HLE is the first time:
  ✓ such a calculation has been done on an individual basis
  ✓ uses established actuarial assumptions of mortality and morbidity
  ✓ based on a multiple decrement modeling approach
Input Assumptions

- Healthy attained age mortality rates
  - Uses first year select SOA mortality rates
- Incidence rates of disability
  - Based on SOA long term care incidence rates
- Attained age mortality rates for disabled lives
  - Based on SOA RP 2014 mortality rates for disabled lives
- Personal information – gender, age, smoker status, exercise and dietary habits, body mass index, income, education level, marital status, sleep habits
Model Calculations and Output

➢ Adjustment factors to input actuarial assumptions based on personal information
➢ Annual total mortality rates of combined healthy and disabled lives
➢ Life expectancy calculations:
  ✓ Healthy life expectancy
  ✓ Unhealthy life expectancy
  ✓ HLE relative index
➢ Unhealthy life expectancy calculation adjusted for cognitive disability
Glimpse of some of the actuarial formulas

➢ \( q_x^{(h)} = P(\text{Healthy life (} x \text{) dies in the coming year}) \)

➢ \( i_x = P(\text{Healthy life (} x \text{) gets disabled at the start of the year}) \)

➢ \( q_x^{(d)} = P(\text{Disabled life (} x \text{) dies in the coming year}) \)

➢ Then \( q_{x+k}^{(T)} = P(\text{Healthy life (} x \text{) dies between } x+k \text{ and } x+k+1) = kp_x^{(h)}(1 - i_{x+k}) q_{x+k}^{(h)} + \sum_{t=0}^{k} t p_x^{(h)} i_{x+t} [k-t| q_{x+t}^{(d)}] \)
Separate formulas developed for HLE, ULE and LE and one test was to ensure LE = HLE + ULE

Independent validation using Monte Carlo simulations with actuarial input assumptions to reproduce analytically developed calculations

Monte Carlo simulations had the added benefit of providing a distribution of realized HLE’s

✓ Quantiles of HLE distribution used to develop adjustment factors for input actuarial assumptions based on personal data
Adjustment factors in HLE calculations

- Calculations naturally adjusted for age, gender and smoking class since input actuarial assumptions varied by these factors.
- A literature review was done to study the impact of other personal factors like diet, exercise, income, education, etc. on mortality and morbidity.
  - Adjustment factors were developed to match a specific quantile in the HLE distribution.
  - A multiplicative approach was used to combine the personal factors.
  - Process involved both judgment and actuarial rigor.
Some illustrative results: Unhealthy Candidate

- Male 60, non-smoker, 5 ft 10in, 230 lbs
- Rarely exercises; < 5 hours sleep; 3-7 drinks per week
- Graduate and annual earnings > $100,000
- Diet and state of health fair

Output

HLE = 22.8 years
ULE = 3.5 years
Cognitive adjusted ULE = 8.1 years
Some illustrative results: Healthy Candidate

- Male 60, non-smoker, 5 ft 10in, 180 lbs
- Exercises 3 – 4 days per week; > 8 hours sleep; 2 to 3 drinks per week
- Graduate and annual earnings > $100,000
- Diet and state of health very good

**Output**

HLE = 34.8 years
ULE = 2.5 years
Cognitive adjusted ULE = 4.7 years
Comments on examples

➢ Incorporating a healthier lifestyle:
  ✓ Increases healthy living by 12 years
  ✓ Causes an increase in ULE by only two years for cognitive adjusted disabled mortality rates

➢ Incorporating an unhealthy lifestyle:
  ✓ Causes an increase in ULE by 5 years for cognitive adjusted disabled mortality rates
Application to individual financial planning

- Annual retirement spending should not be level across expected lifetime of individual.
- During HLE period, retirement spending should be maximized subject to a given level of annual basic expenses.
- During ULE period, basic expenses are expected to increase but discretionary expenses will be significantly reduced.
- Incorporating HLE and ULE in a financial planning model will significantly change optimal spending patterns.
Financial planning illustrative example

- Assume initial assets of $1.5M, i = 6%, HLE = 22 years and ULE = 8 years
- Assume p.v. of basic expenses = 20% of initial assets
- Assume basic expenses are double over ULE period and there are no discretionary expenses
Results of financial planning example

- Financial planning not based on HLE:
  - Annual spending over LE of 30 years approximately $103,000

- Financial planning model based on HLE:
  - Annual spending over HLE approximately $112,000
  - Annual spending over ULE approximately $41,000

- Additional annual discretionary spending is $9,000 or approximately $750 of additional monthly spending
An HLE deferred life annuity for a limited duration of ULE years could be used as a substitute or to complement a long term care policy purchase.

LTC policies could be designed as a deferred limited duration coverage product based on HLE and ULE estimates at underwriting.

The cognitive-adjusted ULE could be used to estimate the additional costs incurred arising from a cognitive disability in LTC.
The HLE model can be enhanced to incorporate:

• a more general definition of healthy and unhealthy mortality rates
• more detailed lifestyle and dietary details
• serve as a patient screening tool for medical providers

The enhanced HLE relative index could be used to develop risk classes for patients and be incorporated into a health care cost predictive model.
The creation of a model which can explicitly measure HLE and demonstrate the impact of lifestyle practices on HLE can add more rigor to current simplified underwriting practices:

- Model results can be obtained in real time
- HLE relative index can be used to differentiate between high and low risk individuals
Application as a wellness tool

- HLE is not a manifest destiny for an individual
  - Lifestyle changes (exercise, diet, sleep, etc.) can have a significant impact on HLE (and ULE)
  - Easy to understand and communicate that increasing HLE increases an individual’s quality of life
  - Understanding HLE and how to maximize it can influence an individual’s retirement lifestyle
Concluding remarks and next steps

➢ Quality of life is directly related to one’s state of health

➢ The research by the Goldenson Center on HLE enables “quality of life” to be quantified explicitly

➢ Many open research questions are available on how to incorporate more rigor on explicitly measuring lifestyle changes on HLE

➢ This research has applications in financial planning, product design, underwriting, healthcare assessment and as a wellness tool
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