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DYNAMIC RETIREMENT FINANCIAL PLANNING MODEL – NOVEMBER 19 2019 ACHS MEETING

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Background

- Research work on this topic has generated two PhD theses in actuarial science – Justin Xu and Qintian Sun
- Demonstrates strategic use of Artificial Intelligence and Data Analytics techniques in actuarial science
- Research work is currently being applied to assist a major Goldenson Center client in developing a commercial retirement financial planning model

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Features of an Ideal Retirement Financial Planning Model

- Actuarially sound and easy to understand
- Completely automated
- Incorporates both insurance and investment strategies
- Model captures both volatility in investment returns and changes in health status
- Has a built-in automated recalibration algorithm that adjusts spending patterns annually
- Eliminates ruin probability

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The Risk for Retirees

- No second chances
  - Spending too much and running out of money when they are still alive
  - Spending too little and not experiencing a quality retirement lifestyle
- Failure to plan for differences in spending patterns depending of state of health of retiree

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Current Retirement Financial Planning Models

- Maximize annual spending under an investment strategy
- Insurance products generally not incorporated in the optimal solution
- Does not incorporate changes in spending patterns due to changes in health status
- Generally not an automated process
- No automated recalibration process that adjusts future spending patterns dynamically to eliminate the ruin probability

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Goldenson Center Dynamic Retirement Financial Planning model

- Has all the features of an ideal retirement planning model
- Models built in R and more recently in Julia to generate solutions in real time (seconds versus hours)
- Uses the MC-MC technique to project future investment returns and health status of retiree
- Uses the AI Kalman Filter technique for annual recalibration of spending and eliminating ruin
- Annual recalibration dynamically connects financial planning with management of retirement assets.
- Maximizes discretionary expenses while ensuring basic expenses are met when the retiree is healthy and unhealthy

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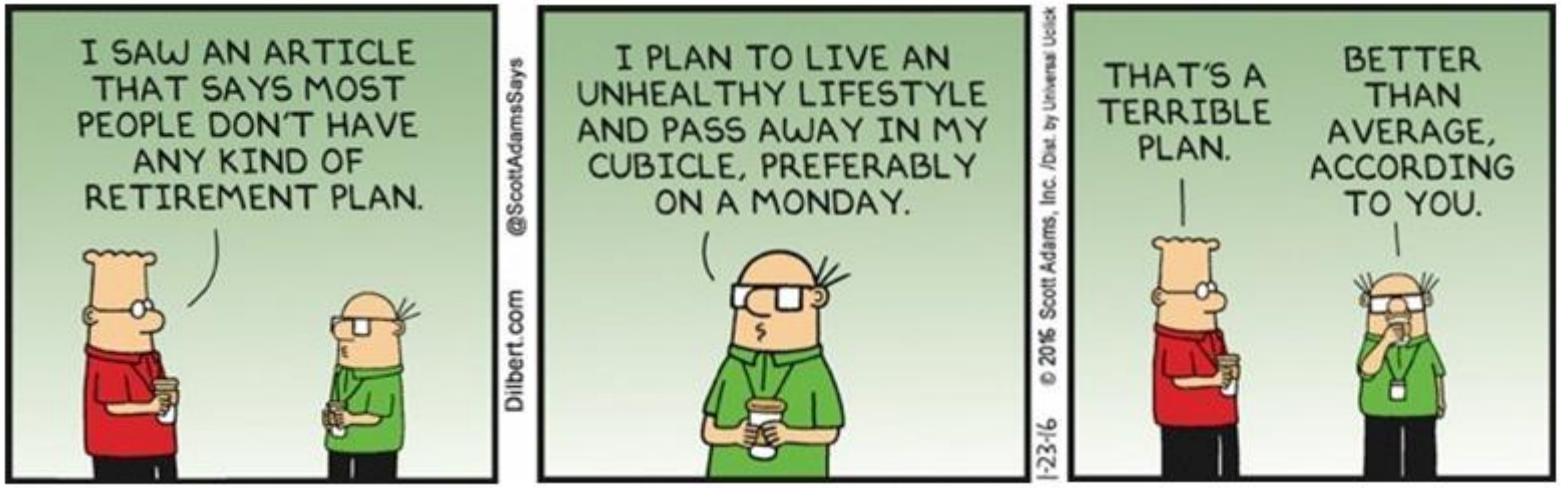
Current Retirement Planning Crisis



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Current Retirement Planning Crisis

- Millions entering retirement every year without a plan
- Goldenson Center model can answer two simple questions:
  - **How much can I spend** in retirement after taxes and inflation?
  - **Will I run out of money** before I run out of breath?

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"[Retirement Income Planning] is a really hard problem. It's the hardest problem I've ever looked at."

– William Sharpe

Nobel Laureate in Economics

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Key features of Goldenson Center Dynamic Retirement Financial Planning Model:

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Incorporate Insurance Products-MYGA's

- Multi-Year Guaranteed Annuities (MYGA)
  - Defined as Fixed Rate or CD-type Annuities, is a type of fixed annuity that provide a pre-determined and contractually guaranteed interest rate for a specified period of time
- Illustrative Examples
  - Assume initial assets of $1M
  - 5-year MYGA at the beginning of retirement, fixed rate = 4%
  - Asset Market: conservative, moderate, aggressive
  - 5% ruin probability

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Results of Financial Planning Example

Asset	MYGA	Opt Allocation	Opt Annual Withdraw
μ=2%, σ=2%	None	0%	$39,857
	5Year, r=4%	77%	$44,090
μ=3%, σ=5%	None	0%	$38,905
	5Year, r=4%	75%	$43,195
μ=10%, σ=15%	None	0%	$50,449
	5Year, r=4%	41%	$54,925

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Comments on Examples

- Incorporating MYGA's to financial planning:
  - Increases annual spending by $4.5K for each market scenario
  - Neutralizes high volatility in aggressive investment
- Optimal allocation of MYGA decreases with increasing asset return

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Incorporate Insurance Products–SPIA's and DIA's

- Use SPIA's to cover basic expenses while healthy
- Use DIA's to cover increase in basic expenses while unhealthy

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Incorporate 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)

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Financial Planning Illustrative Example

- Assume initial assets of $1.5M, i = 6%, HLE = 22 years and ULE = 8 years
- Assume PV of basic expenses = 20% of initial assets and covered by a SPIA
- Assume basic expenses are double over ULE period and there are no discretionary expenses, with increased basic expenses covered by a DIA

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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

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Incorporate Kalman-Filter Re-calibration

- Defined as an algorithm that uses the actual performance of daily market return from previous year as sample data to estimate the real μ and σ
- Combines the result with our prediction at the beginning of previous year based on credibility principles

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Kalman Filter Theory

- Assumes investment returns follow a Brownian Motion process with parameters μ and σ estimated from historical returns
- Prior year's annual returns optimally combined with historical returns to recalibrate μ and σ parameters
- Adjusts our prediction of optimal retirement spending for the coming year using previous year's optimal spending and revised μ and σ parameters

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Incorporate Kalman-Filter Re-calibration

- Illustrative Example
  - Assume $\mu = 4\%$ and $\sigma = 10\%$ at beginning of retirement
  - Future market either goes up to $\mu 1 = 8\%$ and $\sigma = 10\%$, or goes down to $\mu 2 = 1.5\%$ and $\sigma = 10\%$
  - Initial asset is $1M
  - Duration is 30 years
  - Choose the median path from 1000 simulations as the "actual" path given by $\mu 1$ and $\mu 2$
  - Comparison between 5%-ruin simple method and Kalman-Filter Re-calibration method

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Results of Financial Planning Example

	Simple	Kalman-Filter
Ending account value (μ_1)	$5,669,360	$61,074
Average opt withdrawals(μ_1)	$32,051	$100,713
Ruin Probability	0%	0%

- $5.6M left in the account under simple method
- With Kalman-Filter average annual spending is three times that of the simple method
- No ruin for both methods

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Results of Financial Planning Example

	Sample	Kalman-Filter
Ending account value (μ_2)	$128,272	$15,221
Average opt withdrawals (μ_2)	$32,051	$36,273
Ruin Probability	26.4%	0%

- Even under a bad market, Kalman-Filter can still make retiree spend $4000 more per year on average without ruin
- 26.4% ruin probability means that if retiree chooses to stay with $32,051 annual spending, it will be highly likely for the retiree to run out of money before he dies

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Comments on Examples

- Eliminates any ruin during retirement under different market performance
- The entire algorithm is fully automated
- Increases average annual spending and also spends retirement assets more efficiently

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Next Steps

- Market dynamic retirement financial planning model to major insurers and financial planning institutions
- Develop a methodology to replace Target Date Funds with more efficient portfolios using a customized combination of investments and annuities
  - The Goldenson Center's TDF algorithm will be dynamically managed and automated to adjust to changes in investment performance and individual health status
  - Will provide both pre and post retirement optimal investment planning

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Thank you!