

Retirement Saving, Annuity Markets, and Lifecycle Modeling

James Poterba

10 July 2008

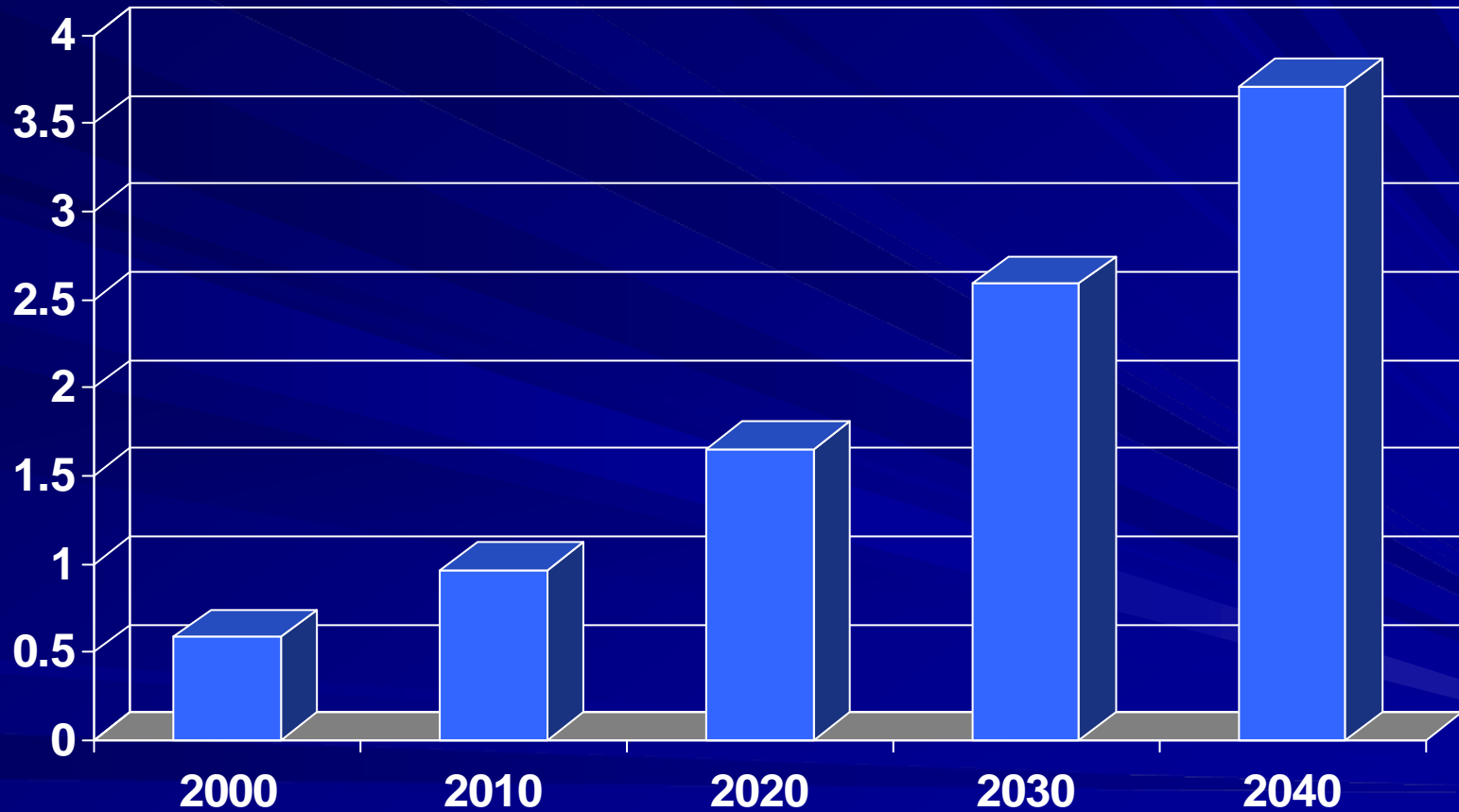
Outline

- Shifting Composition of Retirement Saving: Rise of Defined Contribution Plans
- Mortality Risks in Retirement
- Existing Annuity Products: Prices and Quantities
- Explaining Small Annuity Markets
- New Markets for Trading Mortality Risk

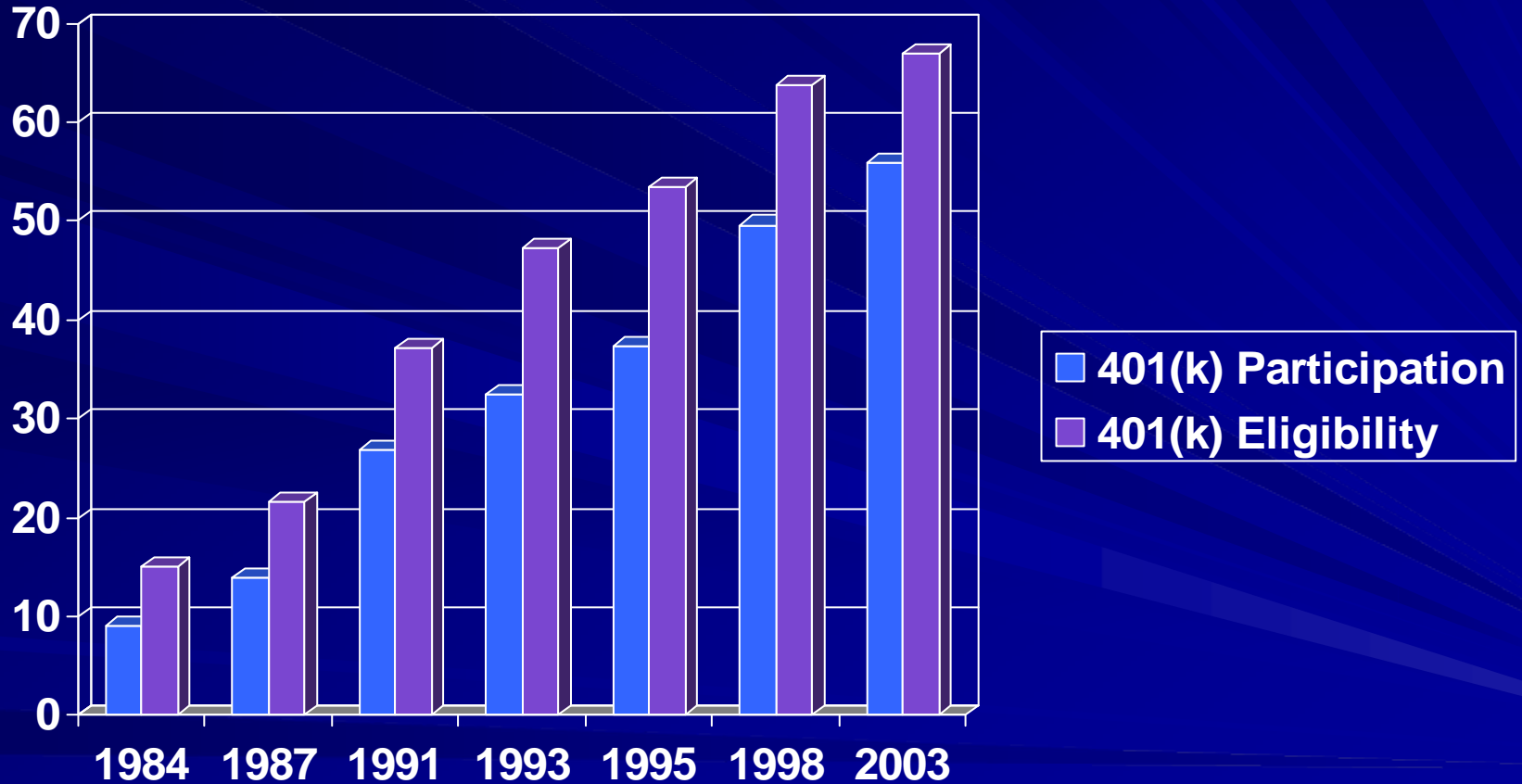
U.S. Private Retirement System: The Shift from Defined Benefit to Defined Contribution

- 1980: Roughly Three Quarters of Pension Contributions in the U.S. to Defined Benefit Plans
- 2005: 73% of Pension Contributions to Defined Contribution (401(k), 403(b)) Style Plans
- DC Plan and IRA Assets in 2006: \$8.3 Trillion (\$16.4T in total retirement assets)
- Future Retirees will have Lifetime Exposure to 401(k)s

Ratio of Projected Defined Contribution Plan Assets to Defined Benefit Plan Liabilities



401(k) Eligibility & Participation Rates, 1984-2003 SIPP



Lifecycle Funds and “Automatic Pilot” Accumulation Vehicles

- Most Rapidly Growing Mutual Fund Category: Assets of \$2.6 billion in 1995, \$39.0 billion in 2000, \$421.0 billion in 2007
- Key Question: What is the Optimal Glide Path Shifting from Equity to Fixed Income as Participants Age?
- Need Dynamic Model of Optimal Lifetime Portfolio Choice

Equity Glidepath for Largest Lifecycle Funds

Years Until Retirement	Fidelity	Vanguard	T Rowe Price	Principal
40	90%	90%	92.5%	85%
20	75	80	90	70
0	50	45	60	45
Retirement Income Funds	20	30	40	17.5

What Determines Optimal Age-Specific Equity Exposure?

- Correlation Between Shocks to Present Value of Human Capital and Equity Market Returns
- Individual / Household Risk Tolerance
- Background Risk
- Options for Varying Future Labor Supply
- Public and Private Insurance Guarantees on Retirement Consumption
- Complex Dynamic Problem: Campbell / Viceira, Gomes / Cocco / Maenhout
- Do Lifecycle Funds Solve the Right Problem?

Shifting Focus from Accumulation of Assets to Drawing Down Assets in Retirement

- Search for Simple Rules: $X\%$ Per Year
- Uncertain Longevity: Classic Yaari Analysis, Absent Bequest Motives and Late-Life Medical Cost Uncertainty, Individuals Should Fully Annuitize
- More Complex Analysis: Potential Medical and Nursing Home Costs, Bequest Motives

Longevity Risk

- Conditional on Attaining Age 25, Probability of Reaching Age 65 is 0.858 for Men, 0.905 for Women
- Conditional on Age 65, Probability of Dying by 75 is 0.254 for Men, 0.189 for Women
- Conditional on Age 65, Probability of Living to 90 is 0.181 for Men, 0.275 for Women

Variation in Male Life Expectancy by Age

Age	E(Remaining Years)	S.D. Remaining Years	Coefficient of Variation
25	55.6	14.5	0.26
35	46.2	13.5	0.29
45	37.0	12.3	0.33
55	28.3	10.7	0.38
65	19.9	9.1	0.46
75	12.8	6.9	0.54

Dispersion of Longevity Outcomes for Married 65-Year-Old Couple

- 38.4 Expected Remaining Person-Life-Years
- 13.5 Expected Years Together
- Expected Years Lived by Widowed Wife: 6.8
- Expected Years Lived by Widower: 4.5
- First Death: 25% Chance by Age 73, 50% by Age 78
- Second Death: 50% Chance After Age 90, 25% After Age 93
- $\text{Prob}(\text{Wife Survives Husband}) = 57.5\%$

Are Mortality Perceptions Rational?

- Hurd / McGarry Compare Subjective Mortality Probabilities in Health and Retirement Survey with Actual
- Men: Survey Average Survival Probability to Age 75: 0.622. “Actual” from Mortality Table: 0.594. Women: 0.663 and 0.746.
- Survival to 85: Subjective 0.388 for Men (0.242 “actual”), 0.460 and 0.438 for Women

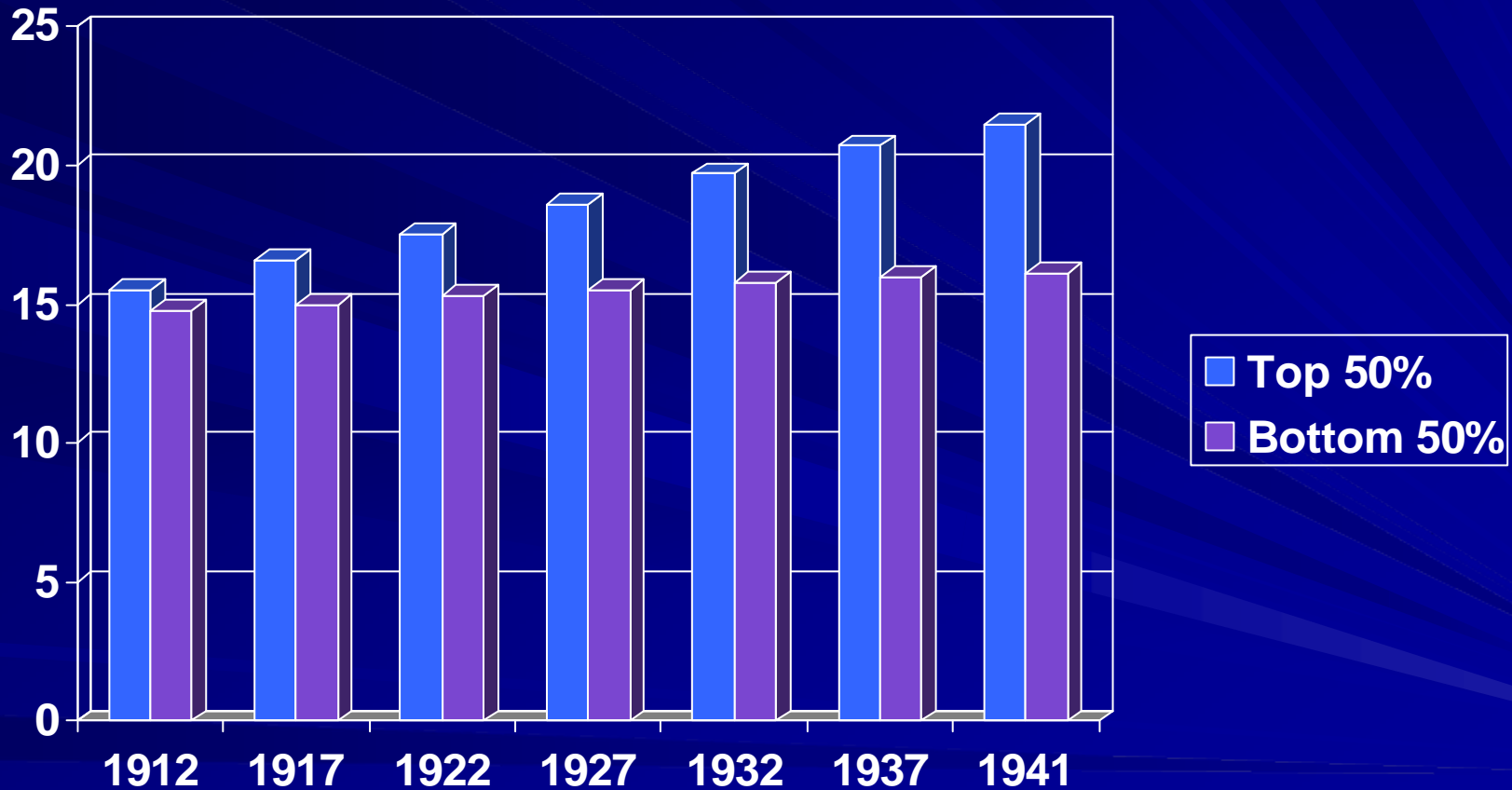
Mortality Variation

- Time Series: Mortality Rates Have Fallen, But at Different Rates for Different Ages (How to Extrapolate?)
- Cross-Sectional: Socio-Economic Status is Strongly Correlated with Mortality Rates
- Time Series/Cross Section Interaction: SES Differential is Growing

Annual Mortality Improvement Rate

	1950- 1980	1980- 2007	1950- 2007
Men, 65-74	-0.53%	-1.61%	-1.05%
Men, 75-84	-0.58	-0.99	-0.78
Men, 85+	-0.56	0.29	-0.14
Women, 65-74	-1.61	-0.49	-1.07
Women, 75-84	-1.57	-0.35	-0.98
Women, 85+	-1.09	0.29	-0.42

Life Expectancy for 65-year-old Males, by Birth Cohort



Intertemporal Consumption Choices with Stochastic Mortality

- Euler Equation with Mortality Risk:

$$U'(C_{t,a}) = S_{t,a} * [(1+r_t)/(1+\delta)] * U'(C_{t+1,a+1})$$

- $S_{t,a}$ = Probability of a-Year Old Surviving for One Year at time t
- S_t Becomes Small in Old Age: Strong Anti-Saving Force in Absence of Bequest Motives

Empirical Issues Concerning Late-Life Consumption

- Key Finding: Heterogeneity is Key
- Does Falling Survivorship Rate Affect Slope of Consumption Profile?
- Do Households Draw Down Assets?
International Evidence – Large Differences
- Annuity Purchases vs. Life Insurance:
AHEAD Data Households 70+, 8% of
Couples Own an Annuity, 78% Own a Life
Insurance Policy

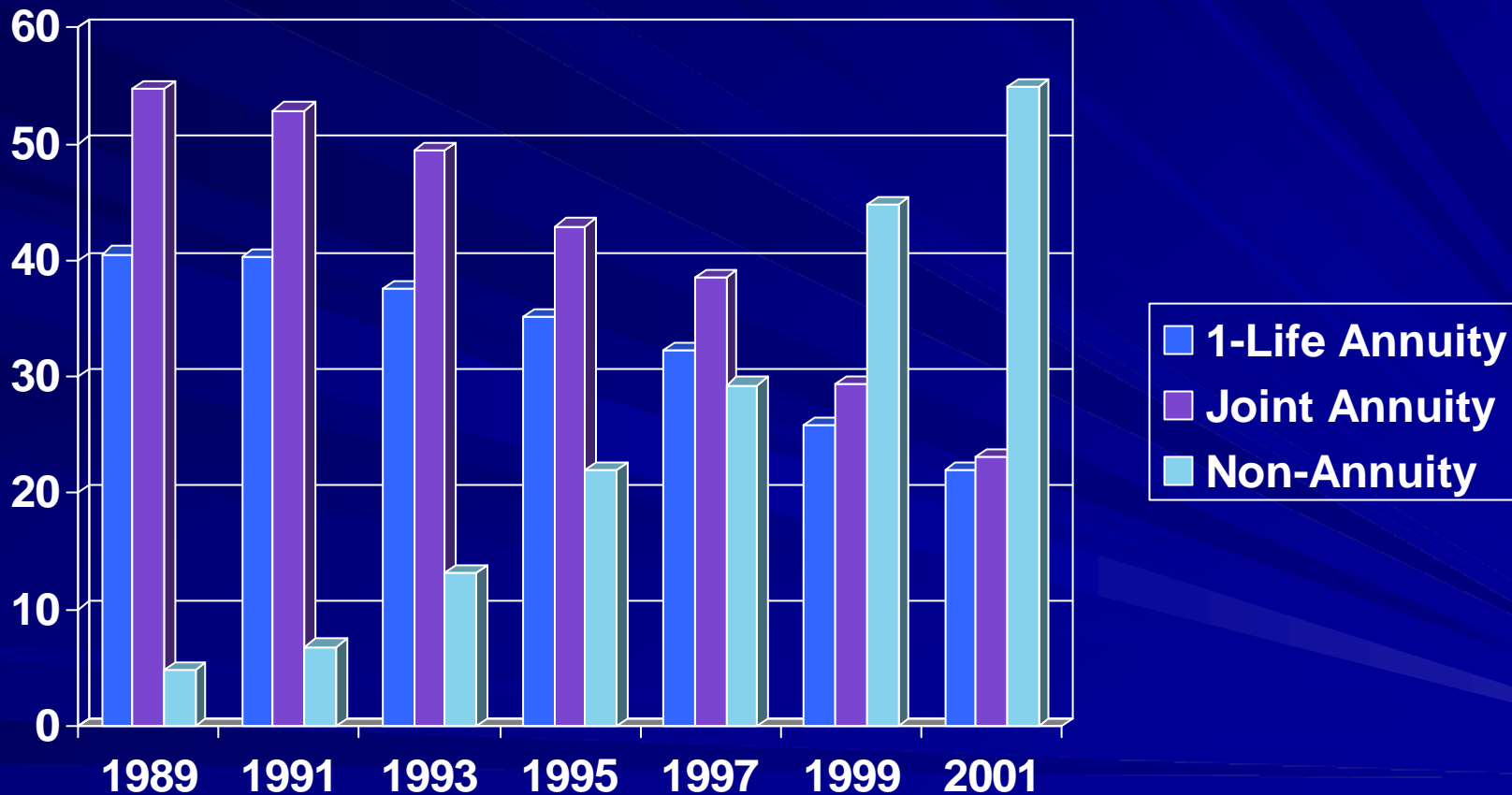
Existing Private Annuity Markets

- Sales of New Single-Premium Immediate Annuities: \$12.8 Billion in 2007
- Variable Annuity Market is Much Larger but Few Assets are Annuitized
- Defined Benefit Pension Plans Provide Group Annuities
- Public Annuities: Social Security, Medicare

Reported Annuity Income: 2004 Survey of Consumer Finances

- Annuitized Income/Total Income for 65-85 Year Old Households: 49.5% (DB Pension Income, Social Security & DI, Private Annuities)
- 85+ Households: Annuity/Total > 80%
- Rising Annuity Share Because of SS & Medicare
- Income from Private Annuities = \$14.6 Billion (3% of Total Income)

Annuity Choices of TIAA-CREF Participants, 1989-2001



THE WALL STREET JOURNAL



chon
day

Payout Options in Large Defined Contribution Plans, 2000 NCS

- 38% of 401(k) Plans, 33% of All Defined Contribution Plans Offer an Annuity Option
- Lump-Sum Distribution is the ONLY Option in 28% of 401(k) Plans, 30% of All DC Plans

Explaining Small Private Annuity Markets

- “DEMAND:” Precautionary Demand for Liquid Wealth, Bequest Motives, Informal Longevity Insurance Provided within Families
- “SUPPLY:” Unattractive Annuity Prices Because of Adverse Selection or Limited Competition

The Role of Annuity Markets in Optimal Social Security Policy

- Eckstein / Eichenbaum / Peled, Diamond, Many Others Cite Absence of Large Private Annuity Market as a Key Potential Justification for Public Retirement Income Program
- 1999 Review of Economic Dynamics Special Issue: Modeling Welfare Effects of Social Security Policies Requires Assumptions About Private Annuity Market
- Insurance Markets are Key for Many Public Policy Issues (Golosov / Tsyvinski)

Expected Present Discounted Value (EPDV) of Annuity Payouts per Premium Dollar

- $EPDV_{NOM} = \sum_{t=1, T} S_t * A_{NOM} / \{\prod_{j=1, t} (1+i_j)\}$
- Survival Rates – Population Life Table or Annuitant Life Table, Projected Forward
- Choice of Bonds for Discount Rates – Riskless Treasuries vs. Risky Corporates
- EPDV Does Not Recognize Insurance Value of Annuity to Individual

Adverse Selection: Comparing Mortality Rates for Annuitants & Population at Large, 2007

	Annuitant Mortality		Population Mortality	
	Men	Women	Men	Women
65	1.02%	0.57%	1.72%	1.16%
75	2.98	1.61	4.29	2.98
85	8.06	5.08	11.35	8.54

Money's Worth of Individual Annuities, December 2007

	Annuitant Mortality Table		Population Mortality Table	
	Cor- porate	Treasury	Cor- porate	Treasury
Interest Rate:				
Men Age 65	0.894	1.009	0.815	0.910
Women Age 65	0.918	1.049	0.817	0.920

Share of Annuity EPDV Associated with Payouts in First Five Years

	Annuitant		Population	
	Cor- porate	Treasury	Cor- porate	Treasury
Interest Rate				
Men, 65	0.383	0.350	0.412	0.381
Men, 75	0.487	0.460	0.538	0.513
Women, 65	0.350	0.317	0.387	0.355
Women, 75	0.439	0.410	0.497	0.471

Why Are EPDV Values < 1 ?

- Insurance Company Administrative Costs or Profits
- Adverse Selection: Annuitant Population is Longer-Lived Than Population at Large
- Risk Premium to Cover Cost of Future Mortality Improvement

Testing for Adverse Selection: Choice of Annuity Policy in UK

- Compulsory Retirement Annuity Market is Much Larger than U.S. Market
- Different Policies Offer Different Features and Individuals can Choose
- Large Insurance Company Shared Data on Ex Post Mortality Experience by Annuity Type

Is Adverse Selection Quantitatively Important? Evidence from the UK Compulsory Annuity Market

- Nominal Annuity
- Inflation-Indexed Annuity
- “Escalating” Annuity (3% per year)
- Nominal Annuity: For 65 year old males, 41% of EPDV is in First Five Years, 6% Beyond Age 85; Contrast with 34% (9%) for a Policy with 3%/Year Escalation (US 2008 Corporate Discounting)

Five-Year Survival Probability, 61-65 Year Old Male Annuitant (Finkelstein-Poterba)

	Compulsory Annuity	Voluntary Annuity
Nominal	0.913	0.951
Escalating	0.970	0.989
Guaranteed	0.911	0.940
Index-Linked	0.962	0.980

Consequences of Adverse Selection in Private Annuity Markets

- Competitive Equilibrium May Not Exist, May Not Be Pareto Optimal
- Possibility of Welfare Gain from Public Action
- Government Policy Actions:
 - Compel Market Participation
 - Regulate Structure of Contracts

Can Insurers Design Contracts to Induce Self-Selection?

- Backloading Payouts Can Induce High-Mortality Households to Select Other Products
- Contract Menu Has Not Included Policies with Strong Age-Related Slope
- Equilibrium Depends on Ancillary Assumptions Such as Saving Technology
- Research Challenge: Calibrating Models with Endogenous Contracts

The Risk of Aggregate Mortality Shocks: Are Insurers Charging a Risk Premium?

- Forecasting Mortality is Difficult
- Risk of Medical Breakthrough Could Change Experience
- Life Insurers are Affected by Illness Shocks (1918 Influenza, AIDS)

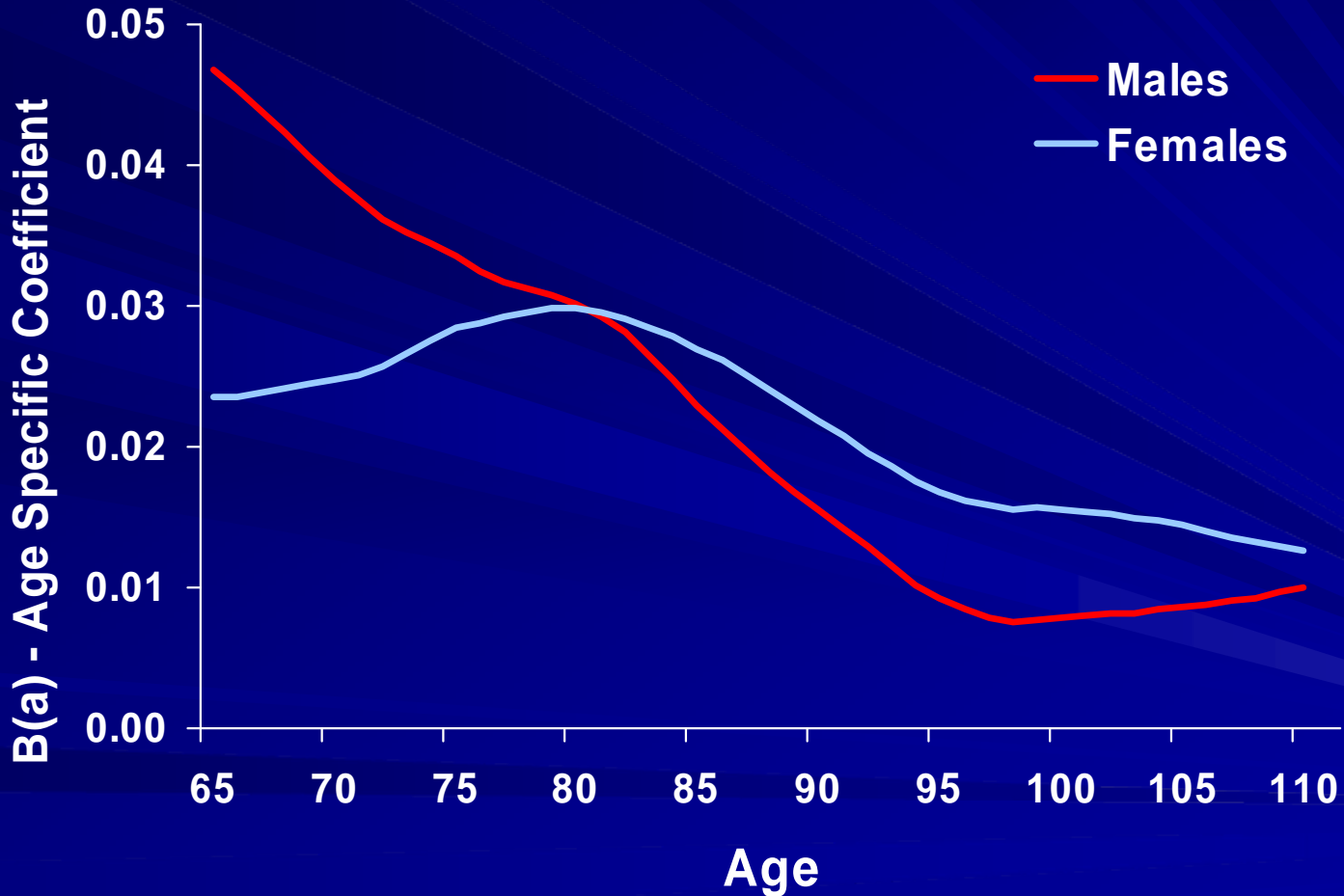
Projecting Mortality Improvement: Beyond Simple Extrapolation

- Lee-Carter (1992 JASA) Model
- Robust and Widely Used
- One Factor Model – No Differences Across Ages, No Cohort Effects
- $m_{a,t}$ = crude death rate at age a in year t
- $\ln m_{a,t} = \alpha_a + \beta_a * k_t + \varepsilon_{a,t}$
- $q_{a,t}$ = mortality rate at age a in year t
- $q_{a,t} = 1 - \exp[- m_{a,t}]$

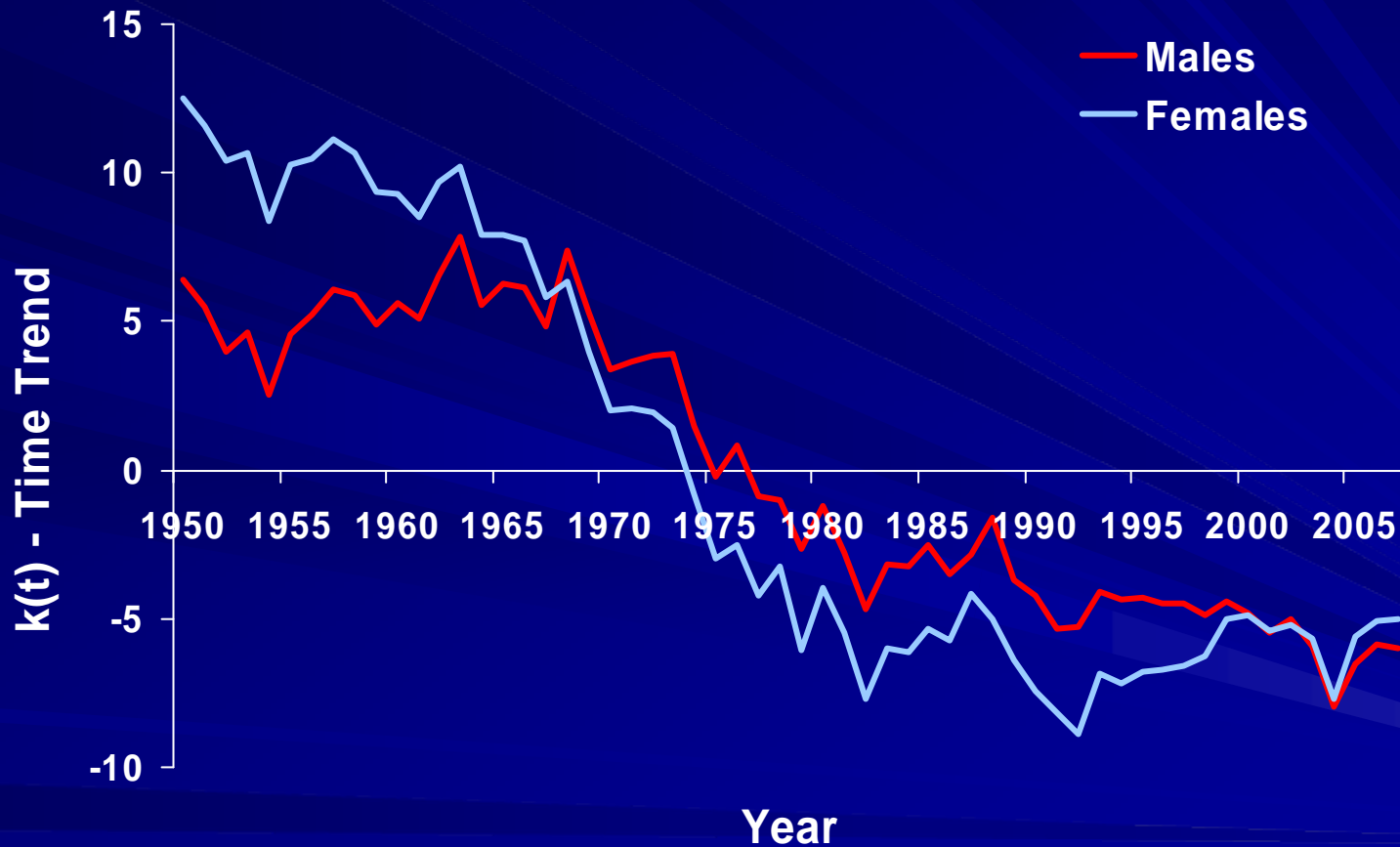
Estimation of Lee-Carter Mortality Model

- $\ln m_{a,t} = \alpha_a + \beta_a * k_t + \varepsilon_{a,t}$
- Normalize $\sum_a \beta_a = 1, \sum_t k_t = 0$
- Aggregate Mortality Factor k_t Follows a Random Walk with Drift
- Estimate for $\{\alpha_a, \beta_a, k_t\}$ for Men, Women over 1950-2007 Period ($a = 65, \dots, 110$)
- Stochastic Simulation of Future Paths of Mortality Rates Can be Used to Compute EPDV of Annuities

Estimates of β_a – Age Specific Loading Factor



Estimates of $\{k_t\}$: Year-Specific Mortality Improvement



Potential Variation in EPDV of Annuity for 65-Year-Old Male, Treasury Discount Rates

Valuation Percentile	Annuitant Mortality Table	Population Mortality Table
5 th	0.966	0.829
25 th	0.992	0.859
Median	1.010	0.878
75 th	1.028	0.897
95 th	1.053	0.924

Dispersion of Life Expectancy at Future Dates in Lee-Carter Projections

- Life Expectancy at Age 75 for a Current 65 Year Old Male
- Median: 87.8 years
- 5-95 spread: 86.5 years, 89.0 years
- 25-75 spread: 87.3 years, 88.3 years

Future Directions in Projecting Mortality Rates

- Disaggregating Mortality by Source: Focus on Cancer, Heart Disease, Alzheimer's...
- Some Demographers Project More Rapid Future than Past Improvements
- Attempt at Explicit Modeling of Rare Events (1918 Flu, AIDS)

Hedging Mortality Risks: Survivor Bonds and Mortality Swaps

- Emerging Financial Markets for Mortality Risks
- Pension Funds, Companies that Offer Life Annuities are Long Mortality Risk (Profit from High Mortality Rates)
- Total Mortality Swap Market: < \$3 Billion

Examples of Mortality-Linked Derivative Instruments

- 2003 Swiss Re Mortality Bond: \$400M Issue, Three-Year Maturity, Payout Depends on Index of Mortality Rates Across Five OECD Nations (“Flu Insurance”)
- BNP Paribas Long-Term Mortality Bond, 2004: Payment at $t = \$50M^*$ (Percentage of Cohort Aged 65 in England & Wales in 2004 that is Still Alive at t)

Should Governments Offer “Survivor Bonds” to Absorb Long- Term Mortality Improvement Risk?

- Governments Are Already Long Mortality Risk – Why Buy More?
- Risk-Sharing through Markets vs. Government

Conclusions

- Exploring Institutions Such as Private Annuity Markets Can Inform Modeling Exercises About Optimal Consumption Planning and Policy Design
- Mortality Risks are Central for Old-Age Consumption Planning
- Dynamic Lifecycle Models Can Inform Security Design: Lifecycle Funds, Survivor Bonds

References

- Finkelstein & Poterba, “Adverse Selection in Insurance Markets,” JPE 2004.
- Finkelstein, Poterba, & Rothschild, “Redistribution by Insurance Market Regulation,” JFinE (forthcoming).
- Mitchell, Poterba, Warshawsky, & Brown, “New Evidence on the Money’s Worth of Individual Annuities,” AER 1999.
- Poterba, Venti, & Wise, “New Estimates of the Future Path of 401(k) Assets,” Tax Policy & The Economy 2007.