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Actuarial Consulting | Retirement Plan Services | Technologies

Pension Risks and Costs

Marek Tyszkiewicz

Pension Risks and Costs

presentation outline

- Longevity Risk
- Investment Risk
- Sharing Risk
- Other Types of Risk

LONGEVITY RISK

What are the limits to longevity?

"Nothing in biology yet found indicates that death is inevitable."

Richard Feynman,

Nobel Prize winning Physicist

Methuselah

tree

Methuselah is a 4845-year-old bristlecone pine tree growing high in the White Mountains of Inyo County in eastern California.

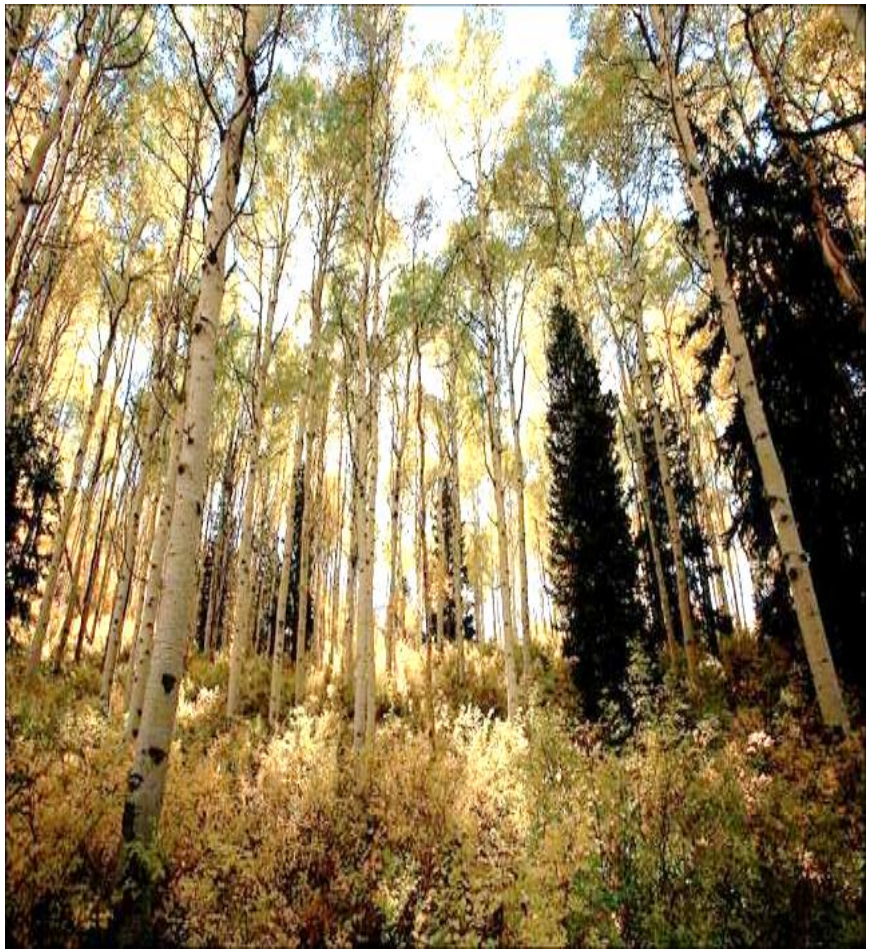
Born: 2831 BC, California

Pando

tree

Pando, also known as The Trembling Giant, is a clonal colony of a single male Quaking Aspen.

Born: 77,987 BC, Utah

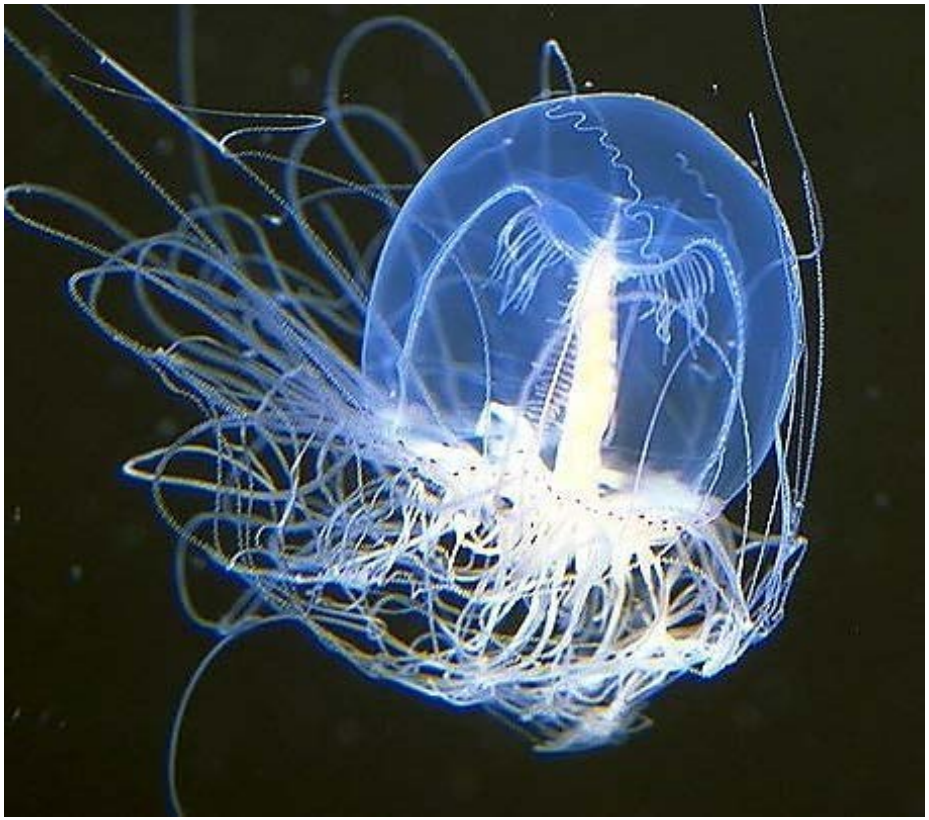


Immortal Jellyfish

animal

Turritopsis nutricula, the immortal jellyfish, can revert back to polyp stage after becoming sexually mature.

Lifespan: Immortal



Aubrey de Grey

gerontologist

"The first human who will live up to 1,000 years is probably already alive now, and might even be today between 50 and 60 years old."

website: www.sens.org

Population Life Expectancy at Birth (2008)

world health organization life expectancy by country

Japan	82.6
Hong Kong	82.2
Iceland	81.8
Switzerland	81.7
Australia	81.2
United States	**78.2 (Rank = 38)**
Zimbabwe	43.5
Lesotho	42.6
Sierra Leon	42.6
Zambia	42.3
Mozambique	42.1

Source: World Health Organization Reports

What if de Grey is right?

impact of immortality on actuarial liabilities

Using 60 year old receiving $1 at the end of each year for life, we get the following present values (also known as annuity factors) using an 8% discount rate assumption:

Using mortality table[1]:	9.5285
Lives to 200 and dies:	12.4997
Is immortal:	12.5000

[1] RP-2000 Projected 10 Years using Projection Scale AA

Annuity values at different ages

life annuity compared to period certain annuities

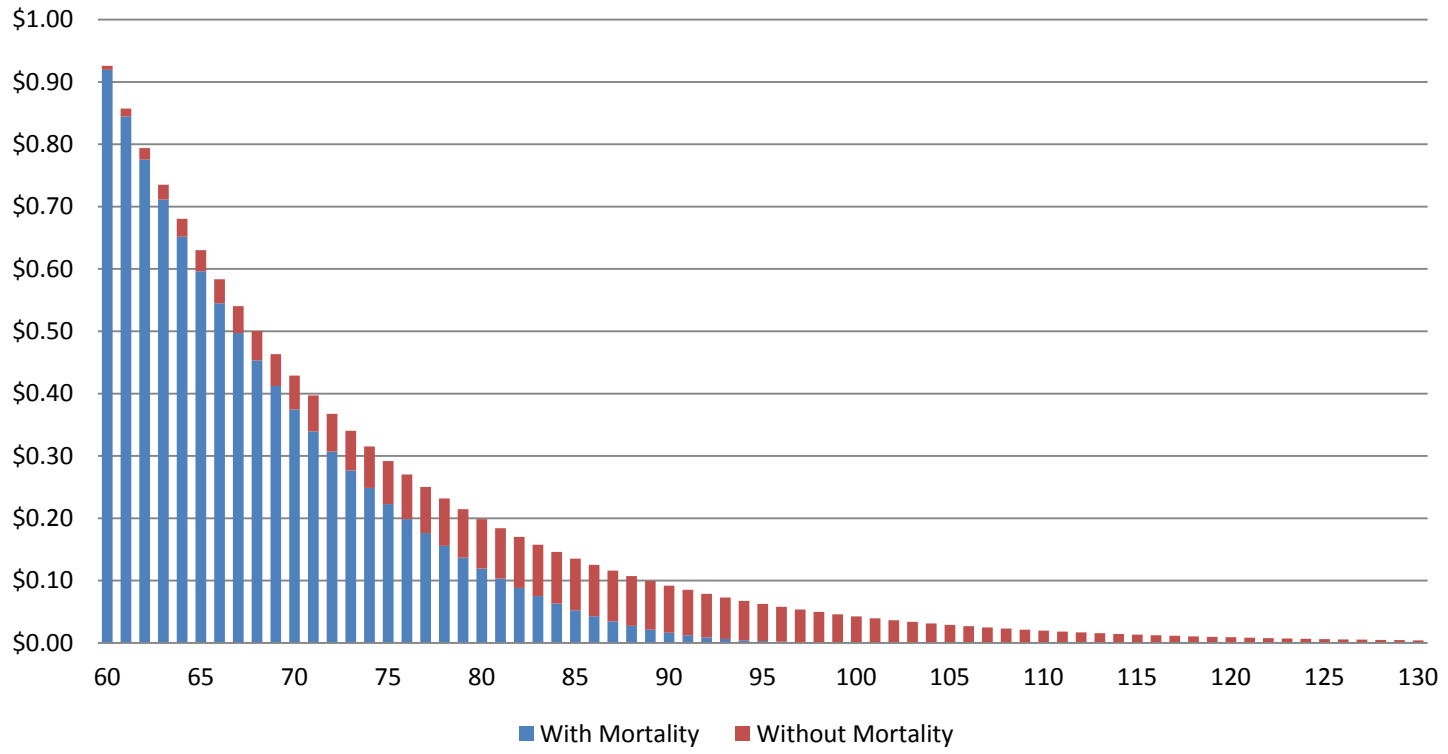
Using 60 year old receiving $1 at the end of each year for life, we get the following present values (also known as annuity factors) using an 8% discount rate assumption:

Using mortality table[1]:	9.5285
Lives to 120 and dies:	12.3766 (29.89% increase)
Lives to 150 and dies:	12.4877 (31.06% increase)
Lives to 200 and dies:	12.4997 (31.18% increase)
Is immortal:	12.5000 (31.19% increase)

[1] RP-2000 Projected 10 Years using Projection Scale AA

Present value of a $1

with and without mortality using 8% interest



Mortality used: RP-2000 Projected 10 Years using Projection Scale AA

Annuity values at different ages

life annuity compared to period certain with COLA

Using a 60 year old receiving $1 at the end of each year for life, increasing 2% annually, and using an 8% discount rate assumption:

Using mortality table[1]:	11.2117
Lives to 120 and dies:	16.1266 (43.8% increase)
Lives to 150 and dies:	16.5695 (47.8% increase)
Lives to 200 and dies:	16.6611 (48.6% increase)
Is immortal:	16.6667 (48.7% increase)

[1] RP-2000 Projected 10 Years using Projection Scale AA

Present values for perpetuities

annuity factor formula for $1 paid at end of year

$$\text{Annuity Factor} = \frac{1}{i - c}$$

Where i = interest or discount rate and c = COLA or growth rate.
Note that if COLA is zero, then this is simply:

$$\text{Annuity Factor} = \frac{1}{i}$$

Present values for perpetuities

approximation for $1 paid continuously during year

Assuming no COLA, then

$$\text{Annuity Factor (EOY)} = \frac{1}{i}$$

$$\text{Annuity Factor (BOY)} = \frac{1}{i} + 1$$

Take average of these two factors to get something close to monthly or continuous payments.

US Population Mortality Improvement

best estimates for the general population 2011-2025

Attained Age	Male	Female
25 – 34	1.50%	1.00%
35 – 44	1.00%	0.50%
45 – 54	1.00%	0.50%
55 – 64	1.50%	1.00%
65 – 74	1.50%	1.00%
75 – 84	1.50%	1.00%
85 – 89	1.00%	0.75%
90 – 94	0.67%	0.50%
95 – 99	0.30%	0.25%
100+	0.20%	0.20%

Source: *Global Mortality Improvement Experience and Projection Techniques.* June 2011

Definition of mortality improvement

terminology

What does a 1% improvement in mortality look like?

Suppose probability of dying during year is 0.05%. Improving mortality by 1% means the new mortality rate decreases 1%, or .01 x .05% = .0005%.

In this case, 0.05% mortality is reduced to .0495%.

Actuarial Standard of Practice No. 35

mortality improvement assumption

The actuary should include an assumption as to the expected mortality improvement after the valuation date. This assumption should be disclosed even if the actuary concludes that an assumption of zero future improvement is reasonable. Note that the existence of uncertainty about the occurrence or magnitude of future mortality improvement does not by itself mean that an assumption of zero future improvement is a reasonable assumption.

Mortality Improvement Assumptions

generational mortality vs. static projection

Generational mortality tables: Each person in the valuation is assigned their own mortality table based on their generation, i.e. year of birth.

Static projection: Algorithm is used to project the table to some future year, for example, 7 years into the future from the valuation date. That table is then applied to everyone in the valuation and experience is monitored. The table is extended again as you near the future date as experience warrants.

Action Items

identify longevity risk

- Open your most recent pension or OPEB valuation
- Turn to section on assumptions in back
- Find section describing mortality assumption
- Determine what assumption is being used for mortality improvements
- If no mortality improvement assumption, discuss why with actuary. Consider including assumption in next valuation.

Predictions are hard, especially about the future.

Famous Predictions

Charles Duell, US Patents Office Commissioner

"Everything that can be invented has been invented."

- Charles Duell, 1899

Famous Predictions

The New York Times

In 1903, the New York Times declares in it's editorial page that flying machines are a waste of time.

Wright brothers complete their successful flight at Kitty Hawk one week later.

Famous Predictions

The New York Times

In 1920, the New York Times also declared rockets cannot move in a vacuum and criticized rocket scientist Robert Goddard's work as nonsense.

Apollo 11 landed astronauts on the moon 49 years later.

Famous Predictions

Albert Einstein, Physicist

"There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will."

- Albert Einstein, 1932

Famous Predictions

Thomas Watson, IBM Chairman

"I think there is a world market for maybe five computers."

- Thomas Watson, 1943

Investment Risk

Predictions About Interest Rates

Michael Bloomberg, Billionaire

"The actuary is supposedly going to lower the assumed reinvestment rate from an absolutely hysterical, laughable 8 percent to a totally indefensible 7 or 7.5 percent.

If I can give you one piece of financial advice: If somebody offers you a guaranteed 7 percent on your money for the rest of your life, you take it and just make sure the guy's name is not Madoff."

Michael Bloomberg, 2012

Predictions About Interest Rates

Peter Lynch, Investor

"Nobody can predict interest rates, the future direction of the economy or the stock market. Dismiss all such forecasts and concentrate on what is actually happening to the companies in which you've invested."

Peter Lynch

Investment Perspective

timeframes for public pension plans

Consider a public school teacher, hired at 25 years old who works to age 60, retires and lives to 85. The plan invests assets on behalf of this member for 60 years. On top of that, new members are continuously hired stretching the plan's investment obligation even longer.

Michio Kaku

Physicist

- Physics professor at City University of New York
- Cofounder of String Theory
- BS (summa cum laude) from Harvard – first in class in physics
- PhD from Berkeley

Physics of the Future

by Michio Kaku

- Book is based on interviews with over 300 top scientists
- Every scientific development mentioned is consistent with known laws of physics
- Prototypes of all technologies mentioned already exist
- Written by "insider" who has firsthand look at these technologies

Michio Kaku's Predictions

rapid rise in computing power

- Cheap computer chips integrated into EVERYTHING
- Internet glasses and contact lenses
- Driverless cars
- Flexible electronic paper
- Virtual reality rooms
- Augmented reality

Michio Kaku's Predictions

medical care in the future

- Virtual doctors integrated with home
- Star Trek tricorders - MRI machines the size of cell phones
- Smart clothes
- Smart toilets
- Cancer effectively eliminated

Michio Kaku's Predictions

fountain of youth

- New organs grown to replace worn out or diseased ones.
- Protein and enzyme cocktails ingested to repair cells, reset biological clocks, etc.
- Gene therapy to slow down aging.
- Exercise and good diet.
- Nanosensors for early detection of disease.

Michio Kaku's Predictions

future of energy

- By midcentury, the game changer, nuclear fusion should provide our solution to cheap and clean energy.
- Fuel is seawater. An 8-ounce glass can release more energy than 500,000 barrels of petroleum. By-product product produced is helium, a commercial product.
- Catastrophic meltdowns don't occur.

Michio Kaku's Predictions

nuclear fusion

- National Ignition Facility (NIF) is using lasers in an attempt to ignite hydrogen fuel.
- High Power Laser Energy Research (HiPER) facility is the European Union's version of NIF. Construction scheduled for 2014.
- International Thermonuclear Experimental Reactor (ITER) using magnetic fields to heat hydrogen gas.

Michio Kaku's Predictions

creating nuclear fusion with ITER

- Physicists claim the problem with using magnetic fields has been solved.
- ITER is expected to heat hydrogen gas to 270 million degrees Fahrenheit. Center of sun is 27 million degrees Fahrenheit.
- Goal is to produce 500 megawatts of energy for at least 500 seconds, 10x the amount of energy used to feed the reactor.
- Target date is 2019

Michio Kaku's Predictions

commercial nuclear fusion

- Following ITER, a Demonstration Power Plan known as DEMO is planned.
- DEMO will demonstrate large-scale electrical power production on a continual basis.
- Target dates:
  - 2017: Conceptual design
  - 2024: Construction begins
  - 2033: Operation commences

Michio Kaku's Predictions

other stuff

- Superconductivity at room temperature
- Fuel efficient magnetic cars

Interest Rate Assumption

impact of interest on annuity factors

Annuity factors for 60 year old receiving $1 at the end of each year for life:

	8%	7%	Δ
Using mortality table[1]:	9.5285	10.3562	8.7%
Is immortal:	12.5000	14.2857	14.3%

[1] RP-2000 Projected 10 Years using Projection Scale AA

Interest Rate Assumption

what's at stake?

Pension plans invest across generations of taxpayers.

Set interest rate assumption too low:

- Liabilities and costs are overstated
- Current taxpayers are overcharged
- Future taxpayers are undercharged

Set interest rate assumption too high:

- Liabilities and costs are understated
- Current taxpayers are undercharged
- Future taxpayers are overcharged

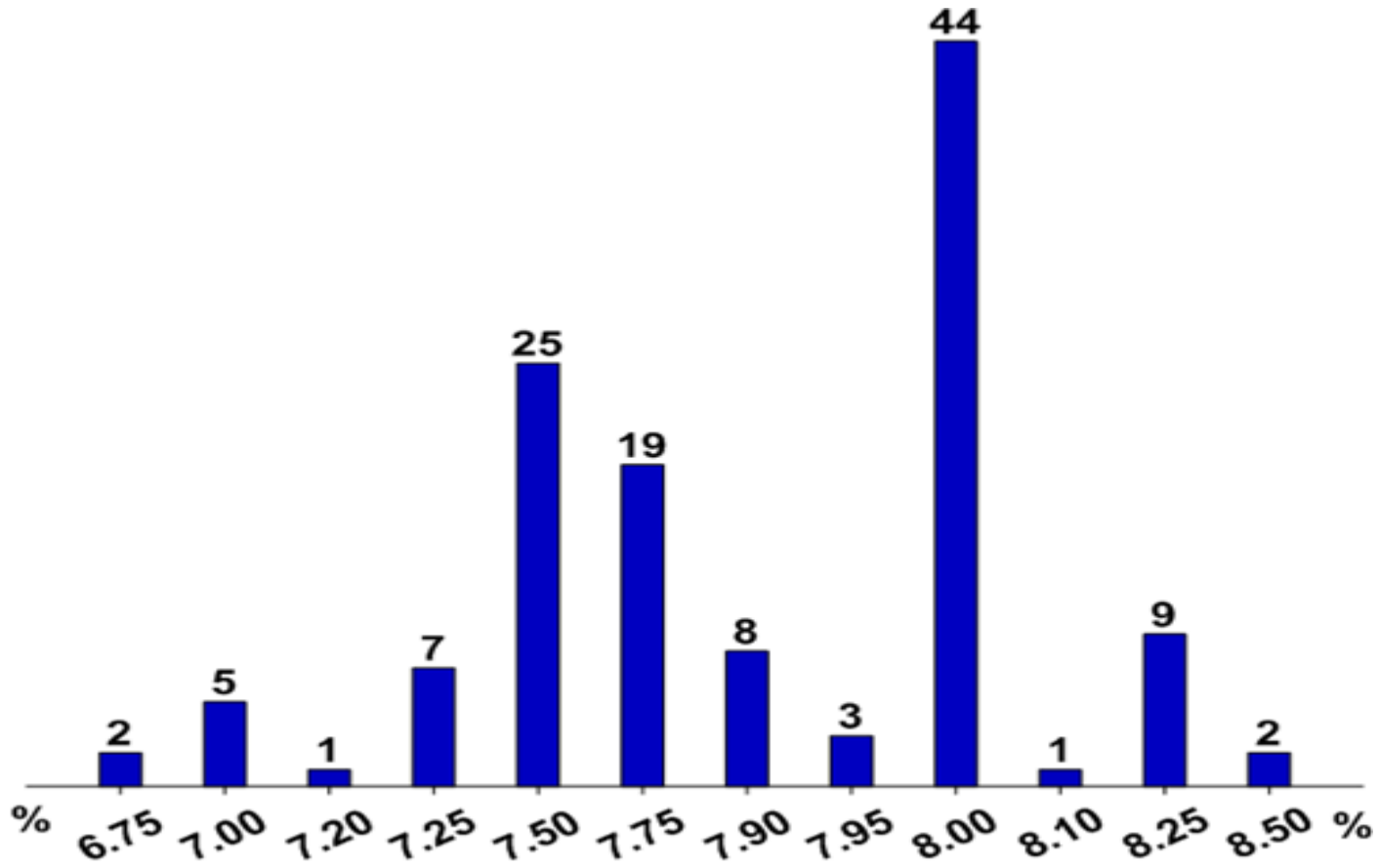
Why assumptions matter

ultimate cost of the plan

Valuations do NOT change the cost of a plan, only the timing of contributions.

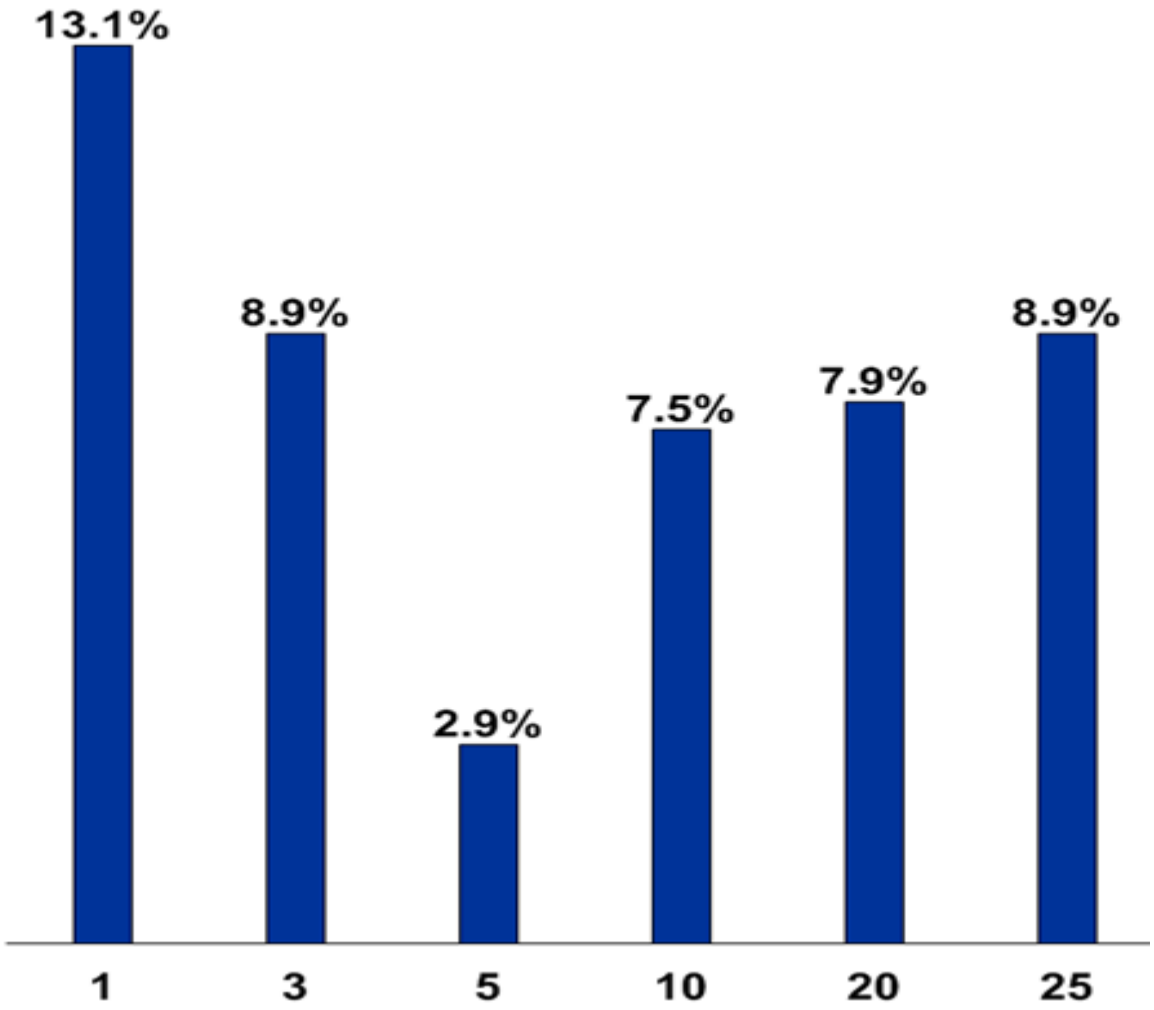
Distribution of Interest Rate Assumptions

126 public sector plans surveyed



Public Fund Survey March 2013

Median public pension annualized investment returns for period ended 12/31/12



Source: Callan Associates, Inc.

SHARING RISK

EBRI Retirement Confidence Survey

2013 Results

Sponsored by the Employee Benefit Research Institute (EBRI), the Retirement Confidence Survey is the longest-running annual retirement survey of its kind in the nation.

Survey consists of 1,254 individuals (80% working, 20% retired) over the age of 25 chosen randomly. Survey consisted of a 20 minute telephone interview in January 2013. Statistical precision is ± 3%.

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that are very or somewhat confident that they will have enough to live comfortably throughout their retirement years.

51%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that think they are doing a good job preparing for retirement.

64%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that are currently saving for retirement.

57%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers where total retirement savings (excluding primary residence and DB plan) is less than $10,000

46%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers where total retirement savings (excluding primary residence and DB plan) is less than $25,000

57%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that spent or used retirement savings from previous employer to pay off debt.

28%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that never tried calculating how much money they need to save for a comfortable retirement.

54%

EBRI Retirement Confidence Survey

2013 Results

Percentage of workers that expect to retire before age 65.

48%

EBRI Retirement Confidence Survey

2013 Results

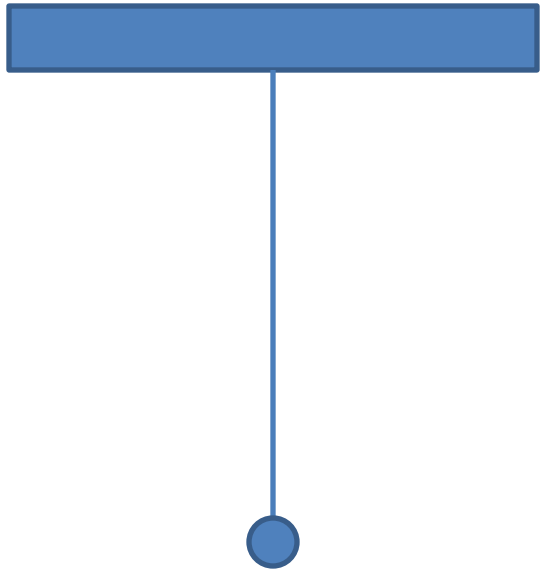
To summarize, over half of US workers:

- Are confident they will have enough to live on in retirement;
- Think they are doing a good job preparing for retirement;
- Have never tried calculating how much they need for retirement; and
- Have less than $25,000 saved for retirement. (46% have less than $10,000.)

Further, almost half (48%) plan on retiring before age 65.

Pendulum of Change

why consultants will always be needed

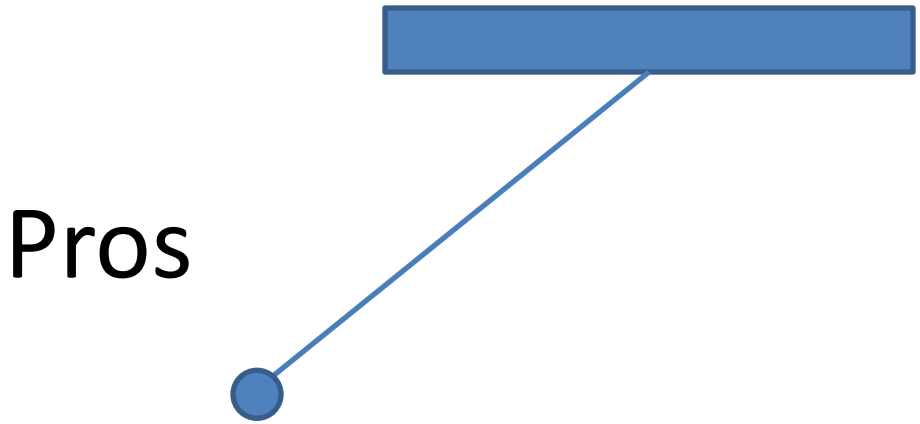


Pro’s

Con’s

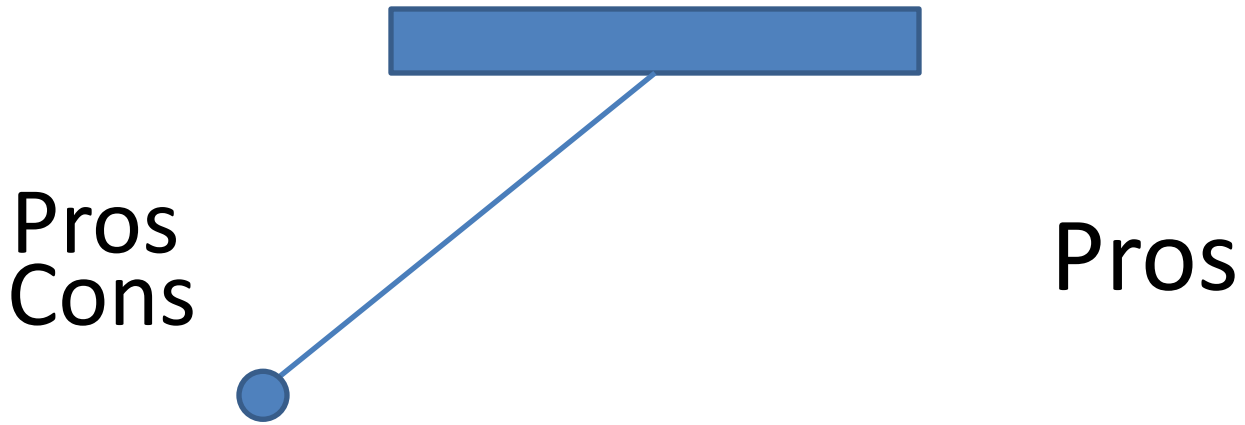
Pendulum of Change

why consultants will always be needed



Pendulum of Change

why consultants will always be needed



Pendulum of Change

why consultants will always be needed

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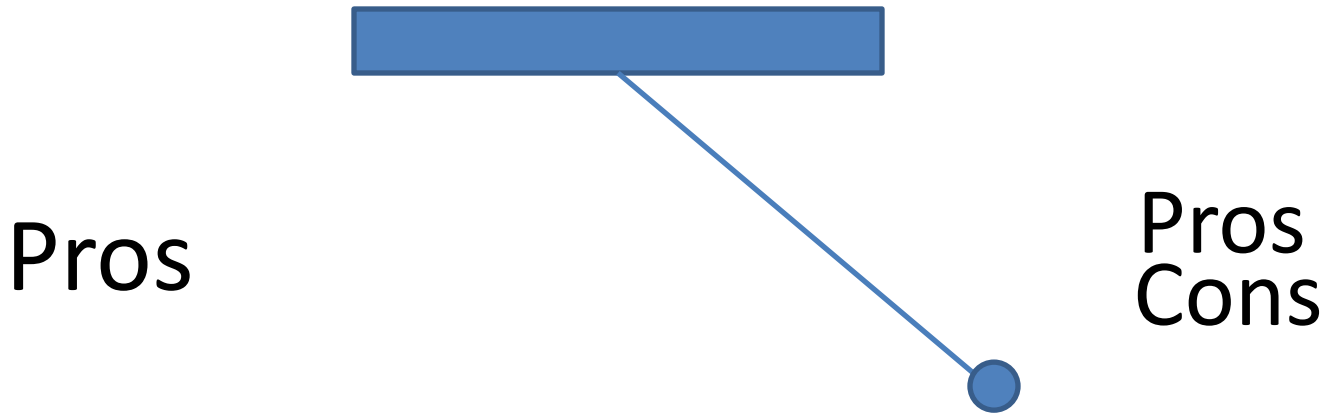
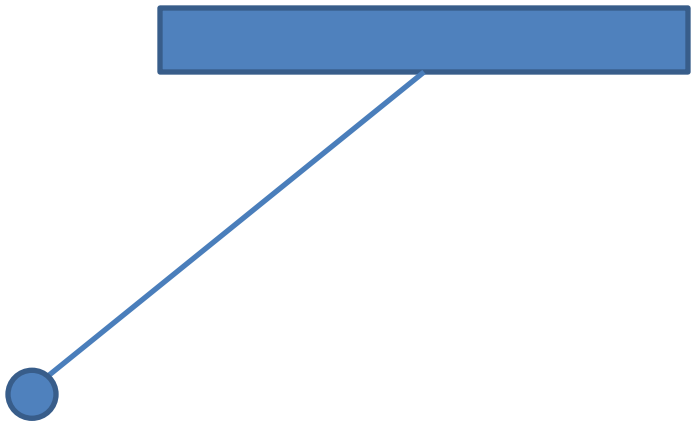


Pendulum of Change

why consultants will always be needed



Pros

Pros
Cons

DB vs. DC

what's the difference?

Defined Benefit (DB)

- Benefit is defined by a formula
- Final benefit is usually related to final pay
- Employer invests the money

Defined Contribution (DC)

- Contribution is defined by formula
- Employee invests the money

Defined Benefit Plan

pros and cons from employer perspective

Pros

- Most efficient way to save for retirement
- Effective tool for recruiting
- Golden handcuffs

Cons

- Investment risk
- Longevity risk

Defined Benefit Plan

pros and cons from employee perspective

Pros

- Most efficient way to save for retirement
- No investment risk
- No longevity risk
- Inflation protection during working career
- May have cost-of-living protection

Cons

- Not as portable as DC plans
- Less income for non-career employees

Defined Contribution Plan

pros and cons from employer perspective

Pros

- No investment risk
- No longevity risk
- Always fully funded

Cons

- Removes the golden handcuffs
- Less bang for the buck

Defined Contribution Plan

pros and cons from employee perspective

Pros

- Portability
- More income for non-career employees
- Financial gains in bull markets

Cons

- Investment risk
- Longevity risk
- Lack of survivor or disability protection

Hybrid Plans

middle of the road solution

Two main types:

- Cash Balance Plan
  - a single plan with elements of both DB and DC plans
- DB + DC Plan
  - Smaller DB plan plus Individual DC savings account

Common features:

- Mandatory participation
- Shared financing between employees and employers
- Pooled assets invested by professionals
- A benefit that cannot be outlived
- Survivor and disability protections

Hybrid Plans

cash balance plan

Plan features:

- Benefits accrue at a steady pace during employment
  - Annual pay credits, e.g. 5% of pay
- Account balance grows with interest credits
  - Fixed rated or variable rate linked to index
  - Accounts are hypothetical
- Investment risk is borne by employer
- Can require employee contributions
- At retirement account balance is converted to life annuity
  - Lump sums may also be paid
  - Rollovers may be allowed
- Can include death and disability benefits

Hybrid Plans

db + dc plan

Plan features:

- Smaller traditional DB plan
- DC savings account
- Employee contributions can be mandatory for either part
- Employer manages DB assets
- Employee chooses how DC assets are managed
- DB component can include death and disability benefits
- Annuity can be paid on DC component
- DC component can be rolled over

Other Types of Hybrid Plans

shared risk plans

Any retirement plan in which risk is shared by employees and employers can be considered a "hybrid" plan.

Plan	Feature
Arizona State Retirement System	ER and EE contribution rates match and fluctuate based on actuarial condition
Iowa Public Employees Retirement System	ER and EE contribution rates fluctuate based on actuarial condition
Nevada Public Employees Retirement System	EE's contribute ½ of ARC
North Dakota Public Employees Retirement System	EE's may direct ER contributions to interest bearing account in lieu of annuity

OTHER TYPES RISK

De-risking Actuarial Valuations

limits of liability

Regardless of limit on liability that may exist in the contract, there is a practical effective limit of liability based on the firm's size. Unlimited liability may be a smaller limit than you think.

De-risking Actuarial Valuations

actuarial audit

Get second opinions. Industry best practice is to conduct actuarial audit every five years if valuations are performed by the same actuary.

De-risking Actuarial Valuations

actuarial audit

TIP: Make sure actuarial audit shows results per person, not just in aggregate.

De-risking Actuarial Valuations

understand actuarial terms and concepts

If you are using asset smoothing, ask for contribution rate and funding percent using smoothed and non-smoothed assets.

De-risking Actuarial Valuations

understand actuarial terms and concepts

Understand that some amortization methods never pay off the unfunded accrued liabilities (UAL). In fact the amortization payment may be less than the interest only payment.

De-risking Actuarial Valuations

level % of pay with closed amortization period

Payroll	UAL	UAL/Payroll	Amort Period	UAL Pmt	% of Pay
$1,000,000	$500,000	50.0%	30	$26,136	2.6%
$1,040,000	$508,864	48.9%	29	$27,181	2.6%
$1,081,600	$517,303	47.8%	28	$28,269	2.6%
$1,124,864	$525,246	46.7%	27	$29,399	2.6%
$1,169,859	$532,614	45.5%	26	$30,575	2.6%
$1,216,653	$539,322	44.3%	25	$31,798	2.6%
$1,265,319	$545,276	43.1%	24	$33,070	2.6%
$1,315,932	$550,375	41.8%	23	$34,393	2.6%
$1,368,569	$554,508	40.5%	22	$35,769	2.6%
$1,423,312	$557,555	39.2%	21	$37,199	2.6%
$1,480,244	$559,385	37.8%	20	$38,687	2.6%
$1,539,454	$559,854	36.4%	19	$40,235	2.6%
$1,601,032	$558,809	34.9%	18	$41,844	2.6%
$1,665,074	$556,081	33.4%	17	$43,518	2.6%
$1,731,676	$551,489	31.8%	16	$45,259	2.6%
$1,800,944	$544,834	30.3%	15	$47,069	2.6%
$1,872,981	$535,903	28.6%	14	$48,952	2.6%
$1,947,900	$524,465	26.9%	13	$50,910	2.6%
$2,025,817	$510,267	25.2%	12	$52,946	2.6%
$2,106,849	$493,039	23.4%	11	$55,064	2.6%
$2,191,123	$472,488	21.6%	10	$57,267	2.6%
$2,278,768	$448,295	19.7%	9	$59,558	2.6%
$2,369,919	$420,118	17.7%	8	$61,940	2.6%
$2,464,716	$387,587	15.7%	7	$64,417	2.6%
$2,563,304	$350,300	13.7%	6	$66,994	2.6%
$2,665,836	$307,827	11.5%	5	$69,674	2.6%
$2,772,470	$259,701	9.4%	4	$72,461	2.6%
$2,883,369	$205,419	7.1%	3	$75,359	2.6%
$2,998,703	$144,439	4.8%	2	$78,374	2.6%
$3,118,651	$76,176	2.4%	1	$81,509	2.6%
$3,243,398	$0	0.0%	0		

Less than interest only payment of $35,000

Level % of pay for budgeting

UAL is paid off at the end

Interest: 7%
Payroll Growth: 4%

De-risking Actuarial Valuations

level % of pay with rolling amortization period

Payroll	UAL	UAL/Payroll	Amort Period	UAL Pmt	% of Pay
$1,000,000	$500,000	50.0%	30	$26,136	2.6%
$1,040,000	$508,864	48.9%	30	$26,599	2.6%
$1,081,600	$517,885	47.9%	30	$27,071	2.5%
$1,124,864	$527,067	46.9%	30	$27,551	2.4%
$1,169,859	$536,411	45.9%	30	$28,039	2.4%
$1,216,653	$545,920	44.9%	30	$28,536	2.3%
$1,265,319	$555,599	43.9%	30	$29,042	2.3%
$1,315,932	$565,448	43.0%	30	$29,557	2.2%
$1,368,569	$575,473	42.0%	30	$30,081	2.2%
$1,423,312	$585,675	41.1%	30	$30,614	2.2%
$1,480,244	$596,058	40.3%	30	$31,157	2.1%
$1,539,454	$606,625	39.4%	30	$31,709	2.1%
$1,601,032	$617,379	38.6%	30	$32,271	2.0%
$1,665,074	$628,325	37.7%	30	$32,844	2.0%
$1,731,676	$639,464	36.9%	30	$33,426	1.9%
$1,800,944	$650,800	36.1%	30	$34,018	1.9%
$1,872,981	$662,338	35.4%	30	$34,622	1.8%
$1,947,900	$674,080	34.6%	30	$35,235	1.8%
$2,025,817	$686,030	33.9%	30	$35,860	1.8%
$2,106,849	$698,192	33.1%	30	$36,496	1.7%
$2,191,123	$710,570	32.4%	30	$37,143	1.7%
$2,278,768	$723,167	31.7%	30	$37,801	1.7%
$2,369,919	$735,988	31.1%	30	$38,471	1.6%
$2,464,716	$749,036	30.4%	30	$39,153	1.6%
$2,563,304	$762,315	29.7%	30	$39,847	1.6%
$2,665,836	$775,829	29.1%	30	$40,554	1.5%
$2,772,470	$789,583	28.5%	30	$41,273	1.5%
$2,883,369	$803,581	27.9%	30	$42,005	1.5%
$2,998,703	$817,828	27.3%	30	$42,749	1.4%
$3,118,651	$832,326	26.7%	30	$43,507	1.4%
$3,243,398	$847,082	26.1%	30	$44,278	1.4%

Less than interest only payment of $35,000

% of pay approaches zero

UAL and payment go to infinity, payroll goes to infinity faster, so UAL as percent of pay goes to zero.

Interest: 7%
Payroll Growth: 4%

De-risking Actuarial Valuations

consider sensitivity analysis

Valuations provide snapshot based on only one scenario and set of assumptions. Consider sensitivity analysis to look at range of possible outcomes, especially for benefit improvements.

De-risking Actuarial Valuations

self-correcting retirement assumptions

How do benefit formula changes impact rates of retirement?

Instead of retirement rates based on age or service, consider rates based on income replaced at retirement.

De-risking Actuarial Valuations

self-correcting retirement assumptions

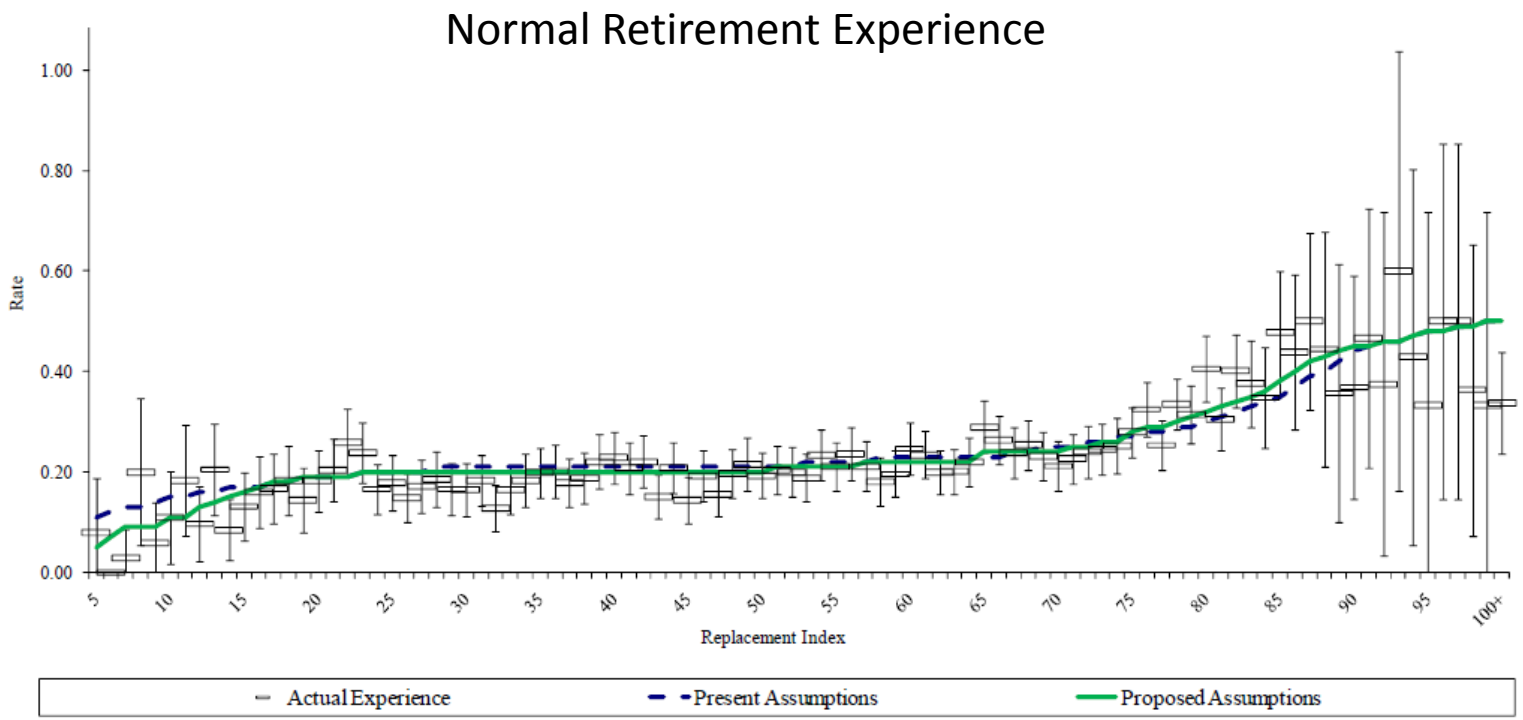
Instead of age or service, the index used is income replacement ratio, RR, defined as:

$$RR = \frac{\text{Pension Benefit}}{\text{Take Home Pay}}$$

where Take Home Pay = Valuation Pay x (1 – Employee Contribution Rate)

De-risking Actuarial Valuations

retirement experience using replacement ratios



De-risking Actuarial Valuations

self-correcting retirement assumptions

Financial items not captured in developing this type of table:

- Personal savings
- Social security benefits
- OPEB Benefits

De-risking Actuarial Valuations

self-correcting retirement assumptions

RR retirement pattern can be reverse engineered into service based pattern for OPEB valuations or for actuarial software not designed for this format.

In this example, the benefit formula is 2.5% of final pay times service and there are no employee contributions.

RR Index	Ret %		Service	Ret %
5	5%		5	14%
10	11%		10	20%
15	16%		15	20%
20	19%		20	20%
25	20%		25	22%
30	20%		30	28%
35	20%		35	42%
40	20%		40	50%
45	20%		45	50%
50	20%		50	50%
55	21%		55	50%
60	22%			
65	24%			
70	24%			
75	28%			
80	32%			
85	38%			
90	45%			
95	48%			
100	50%			

Q&A

Additional Questions or Comments

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