ACTEX Learning

RET 201

Retirement Plan Valuation Comprehensive Summary

1st Edition

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An SOA Exam

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NOTES

Welcome to your preparation journey for the SOA RET101 – Retirement Plan Design / RET201 – Retirement Plan Valuation / RET301 – Actuarial Topics for Canadian Retirement Plans.

This manual follows the official syllabus and presents each topic in a clear, focused manner to help you master the material with confidence and clarity. To complement your study, a set of accompanying flashcards is available for quick reviews, reinforcing key concepts, and keeping your knowledge fresh on the go.

While every effort has been made to ensure accuracy, I warmly welcome your thoughts, suggestions, or corrections at *actuarial613@gmail.com*. Remember—steady progress, disciplined practice, and a willingness to challenge yourself are the keys to success. As a final suggestion, practice is essential. Among the most common reasons for failure, not taking past exams seriously ranks as the number one issue. Candidates are strongly encouraged to attempt the relevant past-year questions published officially by the SOA to maximize their chances of passing.

Best of luck with your studies!

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Selecting and Documenting pension Assumptions other than discount rate,

investment return and mortality

AAA June 2023

General Assumption Selection Process

1. Identify assumption types needed for the measurement
2. Consider relevant factors for each assumption type
3. Refer to ASOP No. 27 (economic assumptions), ASOP No. 35 (demographic assumptions), and ASOP No. 4 (overall measurement guidance)

Key Considerations in Assumption Selection

1. Adjustments for adverse deviation or hard-to-measure plan provisions.
2. Balance between assumption refinement and materiality/cost.
3. Apply unbiased rounding (ASOP No. 27).
4. Ensure no significant bias unless used for adverse deviation or risk assessment (ASOP No. 51).
5. Reflect significant post-measurement date events if known.
6. Use data and input from various professionals; retain professional judgment.

Reasonable Assumption Criteria (ASOP 27 & 35)

1. Fit the purpose of measurement
2. Reflect professional judgment
3. Based on relevant historical/current data
4. Estimate future experience or market-observed data
5. No significant optimism or pessimism unless disclosed and justified

Range of Reasonable Assumptions

1. Multiple reasonable assumptions may exist for one scenario.
2. Different actuaries may select different (but still reasonable) assumptions.
3. ASOPs no longer reference a "best-estimate range."
4. Must assess assumptions not selected by the actuary (unless prescribed by law).

Consistency in Assumptions

1. Economic assumptions must be internally consistent (e.g., inflation, growth).
2. Consistency not required for assumptions not selected by the actuary.
3. Demographic assumptions should also be internally consistent.
4. Review for consistency across benefit plans covering the same group.
5. Reasonableness must be reassessed at each measurement date.

Changes & Phasing

1. Assumption changes typically not phased-in
2. If phased-in, each applied assumption must still be reasonable on its own.

Experience Analysis

1. Full assumption study not required annually.
2. Common practice: detailed review every 3–5 years; lighter annual reviews.
3. Compare actual vs. expected experience, calculate liability gains/losses.
4. Adjust for unusual events (e.g., retirements, lump sums).
5. Focus on trends, not isolated anomalies.

Forecast Assumptions (ASOP 51)

1. Use different assumptions sets for each future forecast date.
2. May include both valuation and "experience" assumptions.
3. Consider dynamic factors (e.g., projected interest rates, future new entrants).

Coordination with ASOP No. 56 (Modeling)

1. Assumptions must be consistent within a model ("where appropriate").
2. ASOP 56 applies to all assumptions—selected or not—unlike 27/35.
3. Conflicts resolved by deferring to ASOP 27/35.
4. Disclose inconsistencies and rationale if they exist.
5. Assess if reused model assumptions remain appropriate.

Credibility (ASOP No. 25)

1. Applies when:
    a. Required by law.
    b. Actuary chooses to evaluate or blend data for credibility.
    c. Data is claimed to be credible.
2. Common blending example: plan experience + standard mortality table.
3. Credibility depends on data quality and availability of other relevant experience.
4. Use caution with atypical or non-recurring experience (e.g., COVID-19 impacts).
5. Refer to SOA's 2017 "Credibility Educational Resource" for practical guidance.

General Requirements (ASOP No. 27)

1. Applies to DB pension plans (not social insurance) for measuring obligations.
2. Includes funding valuations, liability measurements, cash flow projections.
3. Does *not* apply to individual benefit estimates or nondiscrimination testing.
4. Assumption selection also includes giving advice on assumptions.

I. ECONOMIC ASSUMPTIONS

General Process for Selecting Assumptions

1. Identify assumption types based on:
    a. Purpose of measurement
    b. Characteristics of obligation (duration, volatility, open/closed group, etc.)
    c. Materiality to the measurement

2. Steps:
    a. Identify assumption components
    b. Evaluate relevant data
    c. Consider measurement-specific and general factors
    d. Select a reasonable assumption
    e. Review for consistency across assumptions

INFLATION

1. Can be standalone or part of other assumptions.
2. Sources: CPI, implicit price deflator, forecasts, government bond yields.
3. May use select and ultimate rates or location-based variations.

COMPENSATION INCREASE

1. Used for active members with pay-based benefits.
2. Not always required (e.g., frozen plans, traditional unit credit methods).
3. Components: inflation, productivity (real wage), merit/promotion.
4. Can vary by:
    a. Age, service, category (union/non-union), region, or compensation component.
5. Data to consider:
    a. Plan sponsor's current and historical practices
    b. National wage/productivity data
    c. Industry/geographic comparables
6. Professional judgment for data credibility and assumption reasonableness.
7. Measurement-specific considerations:
    a. Temporary freezes, bargaining trends, bonuses/overtime volatility
    b. Plan terminations/freezes
8. May use select/ultimate rates for short vs. long-term patterns.
9. In owner-dominated plans, use tailored assumptions for owners vs. others.
10. Reasonableness checks:
    a. Compare to historical trends
    b. Compare to expected payroll growth, adjusted for turnover

RATE OF PAYROLL GROWTH

1. Differs from individual compensation growth due to new entrants vs. terminations.
2. Used for amortization schedules (e.g., level % of payroll).
3. Approaches:
    a. Combine inflation + real wage growth
    b. Model payroll via continuing members and new entrants

SOCIAL SECURITY WAGE BASE

1. Typically grows faster than inflation, slower than employer compensation increases
2. Based on national average wage growth.

GROWTH OF INDIVIDUAL ACCOUNT BALANCES

1. Needed for plans like:

   a. Cash balance (without fixed credit rate)
   b. Floor-offset plans
2. Consider plan-specific interest crediting provisions.

VARIABLE CONVERSION FACTORS

1. Needed for:
   a. Converting balances to annuities or alternate forms
   b. 417(e)(3) lump sum calculations
2. Influenced by plan-defined conversion rate rules.
3. Subject to legal restrictions in some cases.

COST-OF-LIVING ADJUSTMENTS (COLAS)

1. COLA assumption depends on plan formulae (e.g., CPI-based, ad hoc).
2. Ad hoc COLAs:
   a. Consider past frequency/amounts
   b. Consider sponsor financial health
3. IRS limits (401(a)(17), 415(b)) may be adjusted for inflation, depending on measurement purpose.
4. Legal limits may restrict COLA inclusion in some valuations.

ASYMMETRIC PLAN PROVISIONS

1. When benefit varies more with deviations in one direction (non-linear response), expected value may be inappropriate.
2. Use alternative techniques:
   a. Probability distributions
   b. Stochastic modeling
   c. Option-pricing methods
3. Examples:
   a. Floor-offset provisions
   b. Greater of fixed/variable lump sums
   c. COLAs with hurdles or caps
   d. Cash balance plans with variable crediting and floors/ceilings
   e. Benefits tied to plan investment performance
4. Example: Inflation exceeds 3% triggers COLA → Assume average 0.5% annual increase (even if inflation assumption = 2.5%).

II. DEMOGRAPHIC AND OTHER NONECONOMIC ASSUMPTIONS

GENERAL REQUIREMENTS OF ASOP NO. 35

1. Guides in selecting demographic and noneconomic assumptions for defined benefit pension plans.
2. Applies to measuring plan obligations, assigning costs to time periods, and projecting cash flows.
3. Does **not** apply to individual benefit estimates or nondiscrimination testing.
4. "Selecting assumptions" also includes advising on selection.

General Process for Selecting Assumptions

1. Steps in the process:
    a. Identify assumption types.
    b. Consider a relevant universe of sources (e.g., published tables, plan experience).
    c. Choose an assumption format (table of rates, point estimate).
    d. Select specific assumptions considering:
        i. Measurement purpose
        ii. Plan design
        iii. Relevant experience
        iv. Future expectations
    e. Select reasonable assumptions.
2. Reassessment is not needed every year if assumptions remain reasonable.
3. Consider using different assumptions for different population segments.
4. Assess materiality and potential impact of assumption deviations.

Factors to Consider When Identifying Assumptions

1. Purpose of measurement
2. Plan design and benefit features
3. Characteristics of the obligation (open/closed group, volatility, etc.)
4. Benefit-triggering contingencies
5. Significance/materiality of assumptions
6. Demographics of the covered group

Combining Assumptions

1. Actuary may use a combined assumption for related contingencies (e.g., terminations, disability, retirement).

Testing and Monitoring Assumptions

1. Compare expected vs. actual experience over time.
2. Analyze gain/loss sources.
3. Adjust for one-time events (e.g., early retirement programs, layoffs).
4. Evaluate reasonableness with population characteristics.

Retirement Assumption Specifics

1. Always relevant for active employees.
2. No standard retirement rate tables—heavily plan-specific.
3. Influenced by benefit eligibility rules, industry norms, economic/work conditions.
4. May use plan experience even if not fully credible.
5. Format -Typically age-based tables; may also vary by:
    a. Service
    b. Years since eligible
    c. Sub-population (e.g., salaried/hourly)
6. Can include separate assumptions for:
    a. Special retirement rules (e.g., 30-and-out, Rule of 80)
    b. Commencement ages

7. Extending Beyond Normal Retirement Age- Common now due to:
    a. Increased working age
    b. Financial readiness concerns
    c. Frozen plans or insufficient DC benefits
8. Impact of Purpose on Assumption Format
    a. If valuation focuses on timing or cash flows → detailed retirement probability tables preferred.
    b. If focused on liability or contribution → a single retirement age may be acceptable.
9. Conditions Supporting a Single Retirement Age
10. Actuarially equivalent benefits at all ages.
11. Single age reflects group behavior.
12. Clear retirement age behavior (e.g., subsidy at one age).
13. Limitations
    a. Single-age estimates miss value differences across ages.
    b. Valuation methods (e.g., yield curves) may further distort results.
    c. Must reassess if other assumptions or valuation purpose change
14. External Influences on Retirement Behavior
    a. Plan design (benefit levels, subsidized benefits).
    b. Other employer benefit plans (e.g., disability, retiree health).
    c. Government programs (Social Security, Medicare).
    d. Physical job demands, work environment.
15. Short-Term vs. Long-Term Factors
    a. Recent events (e.g., market downturns, employer distress) may affect short-term retirement trends.
    b. Typically not assumed to persist long-term.
    c. Use of select and ultimate assumptions may be appropriate.
16. Insufficient Retirement Experience - Use industry or peer employer data when plan-specific experience is lacking.

TERMINATION OF EMPLOYMENT

1. General Guidelines
    a. Generally appropriate for active employee valuations.
    b. May be omitted or simplified if:
        i. The assumption does not affect results (e.g., vested benefits actuarially equivalent across all decrements).
        ii. The population is very small, especially for longer-service members.
2. Data Sources & Construction
    a. Past plan experience is a good starting point for medium and large plans.
    b. Factor out non-recurring events (e.g., layoffs, closures).
    c. Construction methods may mirror those used for retirement tables.
3. Assumption Format
    a. Typically tables of termination rates by age and service.
    b. Often includes:
        i. Select period (early years of service): higher turnover.
        ii. Ultimate period: stable rates varying only by age.
4. Alternate formats:
    a. Age-only based tables (used when small plan size or data limitations).

5. When Age-only Tables May Be Appropriate
    a. Plan population too small for credible service-based select period.
    b. Select period deemed immaterial.
    c. Plan closed to new entrants.
6. Weighting Considerations
    a. Short-service employees may show high turnover but may contribute little to liabilities.
    b. Their experience may be deweighted to avoid understating obligations.
7. Factors Influencing Termination Rates
    a. Employment-related:
        i. Industry, job type, union status, work conditions
        ii. Employer policies and financial condition
        iii. Local job market and employment alternatives
    b. Plan-related:
        i. Vesting schedules, early retirement or disability benefits
        ii. Lump sum options
        iii. Other retirement incentives (e.g., post-retirement health, Social Security)
8. When Plan-Specific Data Is Lacking
    a. Use assumptions from similar employers or published tables.
    b. Common source: 2003 SOA Pension Plan Turnover Study.
    c. Adjust for relevance and age of published data.
    d. May apply credibility theory and refer to ASOP No. 25 for blending experience with standard tables.

Disability Incidence and Recovery

1. When to Use a Disability Assumption
    a. Appropriate when the plan provides significant disability benefits.
    b. May not be needed if:
        i. The plan does not offer special benefits on disability.
        ii. Small, unpredictable population.
        iii. Disabilities reflected elsewhere (e.g., termination or retirement assumptions).
2. Data Sources
    a. If plan experience is credible, use plan-specific data.
    b. Otherwise, use published data:
        i. SSA: Actuarial Note No. 2005.6, Studies No. 114, 118
        ii. SOA/AAA: CGDT 1987, 2008 GLTD, 2012 GLTD, Individual Disability Tables
3. Considerations When Using Published Tables
    a. Tables differ by definition of disability:
        i. Own occupation vs. any occupation
        ii. Social Security vs. plan-specific eligibility
    b. Actuary must align table definition with plan provisions.
4. Format of Disability Assumptions
    a. Typically rate tables by age (and possibly gender).
    b. May vary based on:
        i. Type of disability benefit provided
        ii. Plan structure (e.g., different benefits for different job classes)
5. Influencing Factors
    a. Occupation: Riskier jobs = higher disability incidence.
    b. Definition of disability: More generous definitions may increase claims.

c. Level of benefits: High benefits → more likely to claim and less likely to return to work.
d. Other benefits: Availability of Social Security, LTD, Workers' Comp, etc., may influence disability rates.
e. Waiting period: Affects timing and likelihood of disability claims.

6. Credibility
    a. Apply ASOP No. 25 and credibility theory to blend plan data with external data when appropriate.

OPTIONAL FORM OF BENEFIT

1. General Guidelines
    a. Use a form-of-payment assumption when some payment options are materially subsidized.
    b. Assumption should reflect employee election patterns among available options.
        i. When a Single Assumed Form May Be Reasonable
        ii. No form is materially subsidized.
        iii. Subsidized options apply to few participants, so impact is immaterial.
2. Determining Subsidies
    a. Compare plan conversion factors to valuation interest and mortality assumptions.
    b. Consider a range of actuarial equivalence bases for both plan and valuation purposes.
    c. Different results may arise under different purposes (e.g., funding vs. accounting).
3. Reasons to Use a Form-of-Payment Assumption Even If Options Are Equivalent
    a. More accurate for:
        i. Cash flow projections
        ii. Present value calculations with yield curves
    b. Still may be ignored if immaterial to results.
4. Data Sources and Limitations
    a. No large-scale industry studies available.
    b. Plan-specific experience and smaller studies (e.g., Urban Institute, 2003) may help.
    c. Consider participant behavior trends:
        i. Lump sum elections
        ii. Joint-and-survivor vs. single-life annuities
5. Assumption Format
    a. Typically a set of rates totaling 100% across multiple options.
    b. Similar options may be grouped together (e.g., various J&S or period-certain annuities).
6. Segmentation of Participants
    a. May use different assumptions for:
        i. Actives retiring from employment
        ii. Actives terminating before retirement
        iii. Deferred vested participants
7. Factors to Consider
    a. Available benefit forms and start dates
    b. Degree of subsidy for each option
    c. Plan's historical election experience
    d. Recent plan changes (e.g., new actuarial equivalence rules)
    e. Changes to other assumptions (e.g., retirement rates)
    f. Peer plan experience and sponsor communication strategies (e.g., relative value disclosures)

BENEFIT COMMENCEMENT DATE

1. Active Employees
    a. Commencement date may equal or follow retirement date.
    b. Consider plan provisions and historical experience.
2. Deferred Vested Participants
    a. May not start benefits immediately after termination or retirement.
    b. Subsidized early retirement benefits may warrant an earlier assumed start date.
3. Assumption Format
    a. Can be a table of commencement rates or a point estimate.
    b. Tables are better for:
        i. Projections by payment year
        ii. Yield curve discounting
        iii. Plans with lump sum elections or subsidies

ADMINISTRATIVE EXPENSES

1. When to Include - Use if non-investment-related expenses are material and paid from plan assets.
2. Types of Expenses to Include
    a. Actuarial, accounting, legal, trustee, plan admin services
    b. PBGC premiums
    c. Investment management/advisory (if not reflected in return assumption)
    d. Assumption Formats
3. Fixed dollar amount
    a. % of assets, benefit obligations, or normal cost
    b. Reduction in return assumption (for investment expenses)
4. Review and Adjustment
    a. Review annually for:
        i. Service cost changes
        ii. PBGC premium updates
        iii. Extraordinary one-time expenses
    b. Consider sponsor policies on what is paid from plan vs. sponsor directly
5. Measurement Method Considerations
    a. Varies based on purpose:
        i. ASC 715: may embed in asset return or use separate method
        ii. IRC §430: must explicitly add to normal cost
        iii. Partial-year expenses (e.g., spin-offs): may require prorating by timing

HOUSEHOLD COMPOSITION

1. Rarely needed, but may be appropriate if:
    a. The plan provides benefits based on family structure (e.g., children's survivor benefits).
2. Assumption format:
    a. Expected number of family members (e.g., spouse, children).
    b. Average age of each type of dependent.
3. Based on experience/expectations of:
    a. The specific employee group, or
    b. Key employees in small employer plans.

Marriage, Divorce, Remarriage

1. Marriage
    a. Many plans provide spousal survivor benefits, requiring marriage assumptions.
    b. Typical assumption: % married, possibly varying by age or gender.
    c. Include an assumed age difference (e.g., husband older by 3 years).
2. Divorce & Remarriage
    a. Typically not modeled unless material to valuation.
    b. May be considered if divorce/remarriage affects benefit payments or election behavior.
3. Contingent Annuitants (non-spouse)
    a. Consider assumptions if plans allow non-spouse beneficiaries (e.g., children, partners).
    b. May assume % with eligible beneficiaries and age differences.

Open Group Assumption

1. Typically not used in funding/accounting valuations.
2. May be appropriate for projections, modeling, or cost studies.
3. Based on:
    a. Sponsor's hiring expectations.
    b. Past new hire characteristics (age, gender, compensation).
4. Assumption format:
    a. # of new entrants/year or population targets.
    b. Distribution by key traits (age, comp, service eligibility).
5. Avoid simplified assumptions (e.g., fixed entry age or salary), as they may distort projections.

Hours of Service

1. Used for plans where benefits or contributions depend on service hours.
2. Based on:
    a. Recent plan or industry data
    b. Sponsor expectations of future activity
3. Special considerations for:
    a. Partial periods (e.g., mergers, shutdowns)
    b. Frontloading service credits (e.g., 1,000-hour thresholds)
4. Simple proration may be inappropriate if work patterns vary significantly.

Transfers and Return to Employment

1. Transfers
    a. Applicable if participants transfer between plan categories (e.g., hourly to salaried).
    b. May assume frequency, direction, and demographics of transfers.
2. Return to Employment
    a. Consider if rehiring of former participants is frequent or material.
    b. Include timing and demographic characteristics of rehires if relevant.

Unpredictable Contingent Event Benefits

1. Applies to rare events that trigger additional benefits (e.g., plant shutdowns).

2. Challenging due to:
    a. Unpredictable nature of the events.
    b. Potential for material benefit increases.
3. Inclusion of assumption is:
    a. At actuary's discretion.
    b. Based on plan sponsor condition, plan provisions, and valuation purpose.
4. Risk may be better communicated through scenario modeling or range of outcomes.

III. Required Disclosures Related to Assumptions

1. Assumptions Used
    a. Describe each significant assumption.
    b. Indicate if based on:
        i. Estimate of future experience
        ii. Observation of market data
        iii. A combination of both
    c. Include adjustments for adverse deviation or hard-to-measure provisions.
    d. Optionally describe interrelationships among assumptions.
2. Rationale for Assumptions
    a. Provide reasoning for significant assumptions.
        i. For selected assumptions: disclose supporting data and analysis.
        ii. For non-selected assumptions: disclose if they do not conflict with what is reasonable.
    b. Disclose any experience studies used (with date and study period).
3. Changes in Assumptions
    a. Identify changes since last measurement.
    b. Describe:
        i. What changed and why
        ii. General effect (qualitative or quantitative)
        iii. Date and details of any experience analysis
    c. Comply with specific ASOP 27 and 35 requirements (may differ from ASOP 4).
4. Assumptions Not Selected by the Actuary
    a. State the source of each such assumption.
    b. If silent, the signing actuary is deemed responsible.
    c. Other Than Prescribed by Law - Identify if:
        i. The assumption significantly conflicts with reasonableness
        ii. The actuary cannot evaluate reasonableness
    d. Reliance on Other Sources - Disclose:
        i. That another party set the assumption
        ii. The party's identity and reason
        iii. Whether it conflicts with reasonableness or is outside actuary's ability to assess without extra work
    e. May conflict with ASOP 41 vs. new ASOP 27/35—actuary must be aware.
5. Assumptions Prescribed by Law
    a. State:
        i. Law or regulation prescribing the assumption
        ii. The specific assumption(s) prescribed
        iii. That the report complies with the law
    b. Required even if the actuary disagrees with the assumption.

6. Subsequent Events
    a. Disclose any material event:
        i. Known after data cutoff but before report issuance
        ii. that would materially affect results
        iii. Where revising the report is impractical
    b. Also disclose material changes discovered after preliminary findings but before the final report.
7. Deviation from ASOP Guidance
    a. If deviating from an ASOP (outside prescribed or third-party assumptions), disclose nature, rationale, and effect of the deviation
8. Material Inconsistencies - Identify any material inconsistencies among assumptions and explain known reasons.

OTHER NOTES

1. ASOP Nos. 4 and 41 include further disclosure requirements—actuary must review these separately.
2. Disclosure is not required for confidential information.
3. If communication is in a prescribed format (e.g., government form), provide missing disclosures in a separate document (e.g., cover letter).
4. Internal Documentation:
    a. Actuary should maintain workpapers supporting assumption selection.
    b. May include: rationale, data sources, experience analysis, special events, assumption changes.
    c. Degree of documentation depends on complexity and purpose of services.

SELECTING AND DOCUMENTING MORTALITY ASSUMPTIONS FOR MEASURING PENSION OBLIGATIONS

AAA Jan. 2023

I. MORTALITY AND MORTALITY IMPROVEMENT ASSUMPTIONS

1. Published Tables - if actuary judged the plan population is statistically significant, may use its own mortality table or, for partially credible data, using an adjustment to a published table to reflect this experience
2. General Framework of Mortality Assumptions:
   a. Step 1: choose appropriate base mortality tables
   b. Step 2 select (past and future) mortality improvement rates
3. Step 1: To choose appropriate base mortality tables
   a. Factors to consider:
      i. characteristics of employees and retirees (e.g. if reasonable to use different assumptions pre and post retirement)
      ii. size of covered population (e.g. if reasonable to assume no pre-retirement mortality for a small plan)
      iii. characteristics of disabled lives, considering the definition of disability and/or administration of disability provisions (e.g. if appropriate to use a disabled mortality table)
      iv. characteristics of different participant subgroups and beneficiaries (e.g. different tables for white- and blue-collar participants)
4. Step 1: Pri2012 Tables
   a. Approaches when calculating joint-and-survivor annuities
      i. Use retiree mortality for all beneficiaries, except use the rates for the beneficiary's gender;
      ii. Use retiree mortality for the beneficiary (with beneficiary gender, as in Approach 1) while the primary participant is alive and the contingent survivor mortality rates for the beneficiary after the primary participant's death
      iii. Use contingent survivor mortality rates for the beneficiary both before and after the primary participant's death.
   b. White and Blue Collar Tables
      i. Covered populations meet either criteria - the corresponding collar-specific table may more accurately model the mortality patterns of covered population than the "total population" table.
      ii. Covered populations meet neither of the criteria,
         ➢ use the "total population" table
         ➢ segment population into Blue Collar and White Collar and apply the corresponding tables
         ➢ apply a blended Blue/White Collar table, where the proportions used in the blending are based upon the proportions of the underlying Blue Collar and White Collar data
   c. Others Notable Observations
      i. Multiemployer plans participants did not significantly different mortality than those in single employer plans, after "controlling for other factors, such as collar type and income level
      ii. Generally, industry was not found to be a useful predictor of mortality in the data collected
      iii. Salary level and benefit amounts are statistically significant indicators of differences in base mortality rates for nondisabled lives but there are limitations with the income tables
         ➢ certain adjustments that were not made (e.g., payment form, COLA and generational issues)
         ➢ a lack of information about frozen plans, etc.

   d. Pri-2012 rates were developed for both amount-weighted and headcount weighted
      i. amount-weighted mortality rates - appropriate to measure plan obligations.
      ii. headcount-weighted mortality rates - more appropriate for applications e.g. measurement for retirement programs with benefit structure less directly correlated with income (e.g. retiree medical plans)
5. Step 1: Pub2010 Tables
   a. Actives
      i. job category is a statistically significant predictor when looking separately at teachers, public safety, and general employees. Thus, separate tables by category were issued.
      ii. income quartile is the most significant explanatory variable when looking at region, quartile, year, and job category.
   b. Annuitants
      i. job category is a statistically significant predictor
      ii. benefit quartile is the most significant explanatory variable when looking at region, quartile, year, and job category.
   c. Disabled retirees - the only industry that was separated out was for public safety.

II. SELECTING MORTALITY IMPROVEMENT ASSUMPTIONS

1. The considerations for reflecting mortality improvement for pre-measurement date period can be different from those for the post-measurement date period.
   a. In practice, may use a single mortality improvement assumption
2. Two-dimensional mortality improvement scales based on 3 concepts
   a. Short-term mortality improvement rates are based on recent experience
   b. Long-term mortality improvement rates (LTR) are based on expert opinion; and
   c. Short-term mortality improvement rates blend smoothly into the assumed long-term rates over an appropriate transition period.
3. Alternative mortality improvement scales (not the ones selected for the MP Scale) may also be appropriate for modeling mortality improvement.
4. Other considerations for estimating the level of future mortality improvement
   a. When the application of mortality improvement is precluded by law, or requires mandated assumptions;
   b. When characteristics of plan population and general population are different and how the differences might affect the projected rate of mortality improvement. e.g. high-/low-paid , particular occupations;
   c. When benefits are mainly paid out in lump-sum
   d. When pre-retirement death benefit has similar present value as the benefit payable under some other decrement e.g. turnover. I.e. effect of mortality improvements not material.
   e. Plan predominately comprised of active lives who are not expected to choose lump sum benefits
   f. Plan where benefits increase over time (e.g. automatic COLA)
5. Considerations for disabled participants
   a. SOA recommends using the scale for disabled retirees mortality tables, as well as non-disabled mortality tables.
   b. apply general mortality improvement to disabled mortality base table
6. Static vs. generational mortality improvement projections.
   a. Static projection—projects all mortality rates as of the measurement date into the future using selected mortality improvement rates for a specified number of years
   b. Generational projection—generates a unique table for each year of birth cohort
   c. A comparable static projection overstate liability for some and understate it for others
      i. For a large diverse group, actuary may decide to use static projection that may produce a reasonable approximation of a more complex generational projection methodology

7. Select and ultimate assumptions
    a. when short-term assumption are significantly different from the ultimate assumption e.g.
        i. when mortality is affected by the length of time after a particular event, such as disability.
        ii. when a major demographic shift of the workforce is anticipated in the future
        iii. After a significant event, such as the COVID pandemic
8. Forecast Assumptions
    a. May use multiple sets of mortality assumptions, including different types of mortality assumptions.
    b. May use different assumptions for each future date in the forecast period, buy may use "dynamic" projected future static tables when projecting future lump sum
    c. In addition, may need other sets of assumptions ("experience assumptions") to project current data to future measurement periods or illustrate potential risk.
        i. reflect projected "actual" experience as the population evolves from one future date to the next.
        ii. e.g. an assumption for an alternate mortality base table and mortality improvement to reasonably project participants to the forecast measurement date.

III. DISCLOSURE AND DOCUMENTATION

1. Assumptions Used
    a. Describe each significant assumption and to the extent known, whether it represents an estimate of future experience, an observation of estimates inherent in market data, or a combination
    b. Disclose any explicit adjustment made for adverse deviation or for valuing plan provisions that are difficult to measure.
    c. Provide sufficient detail to allow another actuary to assess and understand the assumptions used
    d. Disclose even if assume no mortality improvement for a particular population or period of time
2. Rationale for Assumptions
    a. For each assumption selected, information and analysis used to support the choice
    b. For each assumption not selected, information and analysis to support the actuary's determination that the assumption does not significantly conflict with what is reasonable
    c. Disclosures may be brief but must be pertinent to the plan's circumstances - do not reflect changes planned for future measurement dates.
    d. If an explicit analysis of experience was considered in developing the assumption, disclose the time period analyzed in that study and the date of the study
    e. If mortality table used substantially predates a more recent published one, disclose the rationale
3. Changes in Significant Assumptions
    a. Describe the changes, their general effects, in words or numerically, and, for assumptions that are not prescribed, a brief explanation of the information and analysis that led to those changes.
    b. May disclose the general effects of changes of both demographic and economic assumptions separately or combined
    c. Disclosures may be brief but must be pertinent to the plan's circumstances
    d. May reference any explicit analysis of experience considered when developing the assumption, including the date of the study
4. Assumptions Not Selected by the Actuary (general)
    a. Source of any assumption that the actuary has not selected
    b. If not disclosed, the signing actuary is responsible for that assumption
5. Assumptions Not Selected by the Actuary (ex. prescribed assumptions) - No required disclosure if the assumption does not conflict significantly with actuary's judgment
    a. Any assumption that significantly conflicts with actuary's judgment
    b. Any assumption set by another party that the actuary is unable to evaluate for reasonableness

6. Assumptions Not Selected by the Actuary (reliance on other sources) - disclaims responsibility for a material assumption
    a. The assumption that was set by another party
    b. The party who set the assumption
    c. The reason the party rather than the actuary set the assumption,
    d. either (i) the assumption significantly conflicts with actuary's professional judgment or (ii) the actuary was unable to judge the reasonableness without performing a substantial amount of additional work beyond the scope of the assignment and did not do so , or the actuary was not qualified to judge the reasonableness
7. Assumptions Prescribed by Law
    a. Summary of the applicable law
    b. The prescribed assumptions and disclose that the report was prepared in accordance with that law.
    c. This is required disclosure (even if actuary does not believe the assumption is appropriate)
8. Subsequent Events
    a. discuss any relevant event that
        i. becomes known after the latest information date
        ii. becomes known before the report is issued.
        iii. may have a material effect on the actuarial findings if it were reflected in the actuarial findings, and
        iv. impractical to revise the report before it is issued.
    b. if becomes known (changes on or before the information date) after some findings have been communicated but before the report is completed,
        i. communicate the changes and implications to any intended user to whom the actuary has communicated findings.
9. Deviation From ASOP Guidance - Discuss any material deviation from the guidance including the nature, rationale, and effect of the deviation.
10. Material Inconsistencies—Disclose material inconsistencies among assumptions, and known reasons for such inconsistencies.

SELECTION OF MORTALITY ASSUMPTIONS FOR PENSION PLAN ACTUARIAL VALUATION

CIA Education Note December 2017

2 KEY COMPONENTS

1. Base mortality: Best estimate of current mortality rates for the plan
2. Future mortality improvement scale - Appropriate adjustments for future mortality adjustments

CURRENT LEVELS OF MORTALITY

1. To arrive at the best best estimate, consider
    a. plan mortality experience (where available) and its credibility
    b. experience of similar plans
    c. experience of members with similar longevity characteristics (where available)
    d. published mortality studies, possible adjustments based on individual member or plan characteristics (E.g. collar type, industry, and pension size, and other socio-economic indicators correlated to mortality levels)
2. If one decides to use actual plan experience, appropriately project to the valuation
3. If one decides to use a published table, adjust for mortality improvements between the period of underlying published table data and the valuation date
4. Credibility
    a) Key considerations in developing the best estimate - plan size and the amount of data available to the actuary.
    b) Very large plan (e.g. 10,000+ retirees)
        i) Normally have experience study every 3-5 years
        ii) Plan specific mortality tables or Customize standard mortality table
    c) Mid-size plan (e.g. 1,000+ retirees)
        i) Regularly review mortality experience for significant trends
        ii) Develop broad adjustments to published mortality table
    d) Small plan (e.g. 100+ retirees)
        i) Important to select appropriate assumption,
        ii) Consider employment nature & Amount of pension payment
    e) Very small plan (e.g. few retirees)
        i) Not sufficient data – need considerable judgment
        ii) Adjust appropriate published mortality table
    f) If plan experience is not fully credible, consider if credible data is available for populations with comparable socio-economic indicators
5. Analysis of Mortality Experience
    a) Benefit Amount vs. Number of Lives
        i) If use experience studies to set tables, results weighted on benefit amount (or liability), rather than on number of lives, generally is better
        ii) Results based on number of lives may yield appropriate results for flat dollar benefit plans and / or with relatively homogenous membership characteristics.
    b) Effects of base year
        i) When assessing G/L experience, it is important to consider projections built into the mortality rates.

ii) For fully generational table, no experience G/L implies that the table is representative of current experience
iii) Sufficiency of the provision for future improvements in mortality is revealed in future G/L experience
iv) For static mortality tables (e.g. projected 10 years into the future), no experience gain or loss on pensioner mortality implies experience is already at the level expected in 10 years' time.
v) If experience is credible, imply that all provisions for future mortality improvement have eroded (table out of date)

c) Basis of Comparison
i) If compare plan experience with a published mortality table, analysis would mimic the development of the published mortality table
ii) E.g. 2014 CIA CPM Study determined mortality rates weighted on benefit amount and excluded surviving spouses - preferable if analysis comparing plan experience to the tables provided in the 2014 CIA CPM Study used the same methodology)

d) Evolution of workforce longevity characteristics
i) Longevity characteristics of current pensioners can be markedly different from those of the current workforce.

PUBLISHED MORTALITY STUDIES

1. *The 2014 CIA CPM Study*
   a) Reviewed experience of a number of private and public RPP
   b) first broad experience study for Canadian pension plans
   c) Contains
      i) 2014 Public Sector Mortality Table (CPM2014Publ)
      ii) 2014 Private Sector Mortality Table (CPM2014Priv)
      iii) 2014 Mortality Table (CPM2014)—developed from the combined experience
2. New Information
   a) Actuary consider recent trends and newly published data from these and other sources in developing the current best estimate levels of mortality
   b) Preferable to use studies based on credible experience of Canadian pension plans (rather than foreign
3. Previous Studies
   a) 2014 CIA CPM Study shows current mortality rates are significantly lower and has different age pattern than UP94, GAM94 or RP-2000 mortality rates projected forward using Scale AA
      i) Previous tables are appropriate if supported by credible experience, plan characteristics or other quantifiable evidence
2. Relevance of Certain Mortality Studies – Inappropriate if tables derived from:
   a) General population experience
      i) Though general population tables may provide information on geographical differences – may warrant professional judgment
   b) Individual annuitant data (anti-selection by annuity purchaser)
      i) May only be appropriate for very small plans and individual pension plans

ADJUSTMENTS FOR PLAN CHARACTERISTICS

1. Important factors - employment nature and relative amount of the pension payments
2. Better to modify published tables to reflect actual experience vs. rather than applying data from published mortality studies to adjust for the below characteristics.
   a) E.g. Mortality greater for
      i) Former blue collar than for former white collar
      ii) Former private sector workers than for former public sector workers; and
      iii) Pensioners with small pensions than for pensioners receiving large pensions
   b) Adjusting for plan characteristics not required if:
      i) Plan characteristics not significantly different from composite data underlying published mortality table
      ii) No credible plan experience suggesting actual experience different from underlying base tables
   c) Adjustments for plan characteristics not necessary if mortality rates based on fully credible experience weighted based on benefit amount or liability
   d) Consider adjustments if no credible plan experience available and plan attributes significantly different from the composite data underlying published mortality table
3. For Private/Public Sector
   a) Practical limitation if solely relying public or private sector employment as a determinant for mortality table selection without considering the underlying industry
   b) E.g. sub-groups within the public sector, such as blue collar-type workers, which do not exhibit experience comparable to the broader public sector) Judgment would be applied in selecting between tables based on sector.
4. Collar Type
   a) Mortality experience analysis by collar type in broad-based experience studies may be restricted by the quality of the data available and the ability to classify it into collar types
   b) 2014 CIA CPM Study provided no specific experience by collar type.
5. Industry
   a) Industry analysis has not proven to be conclusive.
   b) Consider adjustment if plan credible mortality experience that is significantly different from average
6. Pension Size
   a) Size adjustments or separate mortality tables for specified salary or pension amount bands (Proxy for socio-economic status)
      i) Reflect correlation between pension amounts and mortality expectation
      ii) Limitation if actual experience not fully credible and industry adjustments not available or inappropriate
      iii) Consider adjustment if pension amounts or active members' earnings levels significantly different from data underlying published mortality study.
   b) Relationship between pension size and life expectancy – correlation I.e. not direct casual effect on socio-economic status or life expectancy
      i) Mobility of plan members (i.e. how long a member stays in one plan during career) - Amounts from one plan may be small relative to overall retirement income.
      ii) Changes in plan design (e.g. closing plans) - Smaller DB paid from the plan over time

iii) When adjusting for pension size, consider whether to reflect factors (mobility or pension size due to plan design)

c) If use size adjustments
   i) Determine a single weighted size adjustment factor for each gender using the average size adjustment factor weighted by pension amount
   ii) Then select associated published mortality table, differing by age and gender, with a percentage adjustment to mortality rates to approximate the effect of applying size adjustments
   iii) Properly adjust for the base year of the projection and mimic the development of the published size factors.
   iv) same adjustments for survivors

d) If no major shift in demographics (occurred or anticipated) – apply the same adjustments to active and deferred members as for retirees.

7. Other Member-Level Socio-economic Indicators
8. Use of pension size is a proxy for socio-economic status.
9. Where credible mortality experience data is available and calibrated using a factor linked to socio-economic status, other member-level factors may be used as proxies for socio-economic status (e.g. postal code and level of education)
10. Combinations of adjustments for plan characteristics
    a) Reasonable approach - consider adjusting published mortality table based on each characteristic separately
    b) helpful in narrowing down a reasonable range and selecting a final assumption.
11. Graduation of rates – for smoothing mortality rates
    a) After adjusting standard table mortality rates or preparing a plan-specific table, rates in the resulting table may need to be smoothed so that the rates progress in a reasonable pattern from age to age

ADJUSTMENT FOR FUTURE MORTALITY IMPROVEMENT

1. Develop best estimate of future mortality improvement rates
   a) A short-term rate based on recently observed improvement rates;
   b) An ultimate long-term improvement rate, which is highly uncertain; and
   c) A transition from the short-term to the ultimate improvement rates over a certain period and based on a particular pattern.
2. 3 common methods of providing adjustments for future improvements in mortality:
   a) Two-dimensional (2-D) generational mortality tables;
      i) improvement rates vary by year and age
   b) One-dimensional (1-D) generational mortality tables
      i) Improvement rates vary by age only
   c) Static mortality tables with a fixed projection period
3. 2-D Generational Mortality Scales
   a) Examples: CIA MI-2017 and CPM Improvement Scale B (CPM-B)
   b) Allow mortality improvement rates to vary by age and calendar year
   c) Use and Appropriateness: Both scales are relevant for the Canadian population and either may be used in the absence of credible evidence to the contrary

   d) Assumptions and Methodology:
      i) MI-2017: Includes transition from higher short-term to lower ultimate improvement rates
      ii) CPM-B: Based on actual pension plan experience and CPP assumptions
   e) Flexibility in Application:
      i) Other 2-D scales may be appropriate
      ii) Acceptable if supported by a considered and documented rationale
      iii) Reflects uncertainty in future mortality improvements
4. 1-D Generational Mortality Scales (vary by age only)
   a) E.g. CPM Improvement Scale B1-2014 (CPM-B1D2014), Scale AA
   b) Commonly used in the past - Now acceptable uses include
      i) if it reasonably approximates the financial impact of a suitable 2-D scale at the valuation date
      ii) Can simplify calculations under certain valuation systems
      iii) if the actuary believes no transition from short-term to ultimate improvement rates is needed (e.g., when ultimate rates ≈ short-term rates)
5. Static Mortality Rates with Fixed Projection Periods
   a) Shortcomings:
      i) May lead to inappropriate current service costs or liability allocations by cohort or membership category
      ii) Frequent updates at each valuation to reflect new base mortality rates, changes in liability duration and revised projection periods
   b) Actuary must ensure results are appropriate for the intended purpose and consider and address limitations
6. Reviews of Mortality Improvement Rates
   a) Consider emerging trends and studies on a regular basis (esp. Canadian pensioners)
   b) Adjustment for future improvements normally considered separately from the current level of mortality

SPECIAL SITUATIONS

1. Pre-retirement mortality
   a) Generally not important to liabilities calculation, except
      i) Benefits are significantly different from CV
      ii) Actual death rates significantly > expected
2. Disabled life mortality (Higher mortality)
   a) If use separate assumption, adjust that of other retired groups
      i) Standard table reflects all retired members

SENSITIVITY

1. Possible sensitivity disclosures include:
   a) Change in current service cost or normal actuarial cost.
   b) Change in the actuarial liabilities, accounting obligations or PV of accrued benefits
2. Approaches to measuring sensitivity of disclosure item to changes to the mortality assumption are:
   a) Impact of life expectancy of members being one year higher than assumed (age set-back could be used to estimate the effect of increased life expectancy)

   b) Impact of a percentage adjustment to mortality rates (e.g. decrease mortality rates at all ages by 10%)
3. Other approaches
   a) Altering the ultimate long-term rate and adjusting the transition between the short-term and long-term rates in a manner consistent with the underlying published mortality study

APPLICATION

1. Use of Pension Mortality Assumptions for Other Purposes
   a) In selecting best estimate mortality assumption for non-funding purposes consider whether different provisions, membership and liability structures would call for alternate assumptions
2. New Experience Studies
   a) Refer to Standards of Practice
   b) Publication of mortality experience study is a subsequent event that provides information about an entity as it was at the calculation date

Forecasting Investment Returns and Expected Return Assumptions for Pension Actuaries

AAA Feb 2019

1. Actuarial professional guidance regarding the investment return assumption.
   a) ASOP No. 27, Selection of Economic Assumptions for Measuring Pension Obligations.
   b) ASOP No. 23, Data Quality; the definition of "data" under this ASOP includes information derived mathematically from data.
   c) ASOP No. 41, Actuarial Communications.
2. Internal rate of return concept underlying return forecasts
   a) IRR - interest rate at which the net present value of all cash flows for an investment, including initial investment, is zero. (for setting expected future return / benchmark)
   b) discount rate that equates future payments with the current present value of pension liability.
   c) yield on bond or a fixed income benchmark - present value of all future coupons and face value at maturity = current bond price
3. Mapping a portfolio's asset allocation to the asset classes and sub-asset classes.
   a) When determining the expected return for a portfolio, each specific investment may not have a direct and obvious match (especially hedge fund or derivative strategies)
4. Asset allocation basis: most recent versus investment policy targets
   a) Formal investment policy statement (IPS)
   b) Defines target asset allocation at the time of valuation. 3 possible scenarios are:
      i) Actual holdings are as stated in formal Investment Policy Statement (IPS)
      ii) No IPS – Use actual asset allocation to set expected return. If allocation will change, use average allocation over time
      iii) Differs significantly from IPS: Understand reasons for the discrepancy – If divergence is temporary, use target allocation. If permanent, use actual holdings.
5. Adjustments for potential future changes in asset allocation.
   a) asset allocation can change over time –
      i) sponsor to adopt and phase in a new investment strategy
      ii) plan population is maturing – adjust to accommodate more outgoing cash flow
      iii) changes dynamically based on funded ratio or other metric expected to change over time.
      iv) Planned to go into or out of an illiquid asset class (i.e. gradually over time)
   b) Actuarial measurement - guide reflection of these kinds of changes in the expected return assumption.
      i) If measurement is a snapshot of plan status - can disregard anticipated future asset allocation changes
      ii) If measurement is for setting long-term contribution budget / other multi-period measure - account for the anticipated changes.
      iii) If measurement is for funding, accounting, or other disclosure requirements - Apply applicable rules and regulations
   c) 3 ways to reflect anticipated changes in the asset allocation in the expected return assumption
      i) Blended expected return assumption – when pattern of allocation changes is known in advance - considers both the timing of future plan cash flows and of the expected changes in the investment mix.
      ii) Select-and-ultimate - can consist of several different rates covering different time periods.

iii) Base the expected return assumption entirely on anticipated future asset allocation, i.e. no weight to the current allocation (E.g. gradually moving substantially over to private equity placement – i.e. ultimate allocation may be the most relevant.)

6. Impact of volatility and correlations on total portfolio return.
   a) The higher the volatility of a portfolio, the bigger the difference between the expected geometric return and the expected arithmetic return.
   b) Expected arithmetic return - asset-allocation-weighted-average expected arithmetic return for each asset class
   c) Expected geometric (compound) return depends on:
      i) assumed distribution of returns;
      ii) assumed correlations between returns for different asset classes;
      iii) assumed relationships between returns for different years; and time horizon.
   d) 2 approaches to calculating the expected geometric return
      i) Assume independent and identically distributed lognormal returns.
      ii) Stochastic model incorporates one or more of: Different returns distribution; serial correlations between investment returns in one year and subsequent years; changes in capital market assumptions over time; Dynamic correlations between asset classes
      iii) Result is a probability distribution of geometric returns for the desired time horizon, and the 50th percentile is an estimate of the expected geometric return.
7. Use of historical data.
   a) Historical returns - not a good indicator for the future
   b) Better is to analyze historical data for components of return forecasts (e.g. yields, P/E ratios) together with historical returns to understand how current levels of those factors might affect the individual components that make up an investment return assumption.
   c) Estimates of volatility and correlations are based primarily on historical data (different from historical returns)
   d) Relevant historical period should cover a full market cycle (bear, recovery, and bull) i.e. 5 to 20 years
   e) Different return forecasting models use historical data differently
      i) Mean for future returns (or interest rates) may be assumed to fully or partially revert to the historical mean over some period.
      ii) Mean for a future return is sometimes assumed to equal the historical mean. But for most asset classes, current market conditions such as equity prices, anticipated economic growth, are better future return indicators
      iii) May add historical risk premiums to forecasted risk-free rates.
      iv) The building block approach is useful for estimating future returns. Note: historical risk premiums may not be good indicators of future risk premiums)
   f) Historical market data can be useful for other purposes, such as analysis of relationships and trends in economic and other capital market indicators. Some forecasting models are built based on such market data analysis.
   g) Using or not using historical data is not an indicator of an appropriate or preferable process.
8. Reflecting targeted rates of return from an investment policy statement.
   a) One approach - use targeted return specified in IPS
      i) does not factor in current market conditions
      ii) does not bear any relationship to a reasonable return expectation.

9. Reflecting time horizons for determining expected returns.
   a) Validity of future return forecasts depends on the time horizon for the forecast.
   b) If return forecast time horizon extends beyond 15-20 years
      i) current market conditions become less relevant - use long-term fundamental expectations (e.g. reversion to historical mean)
   c) Important to consider transition time from current conditions to the assumed long-term equilibrium state
10. Use different return expectations for different time periods.
   a) When expected returns differ for different time periods, may align expected returns with each future cash flow from the plan
      i) Use select-and-ultimate return assumption or develop a single equivalent discount rate
      ii) for a given set of return expectations, the single equivalent discount rate might be different for plans with same asset allocation but different maturity profile
11. Data to support an inflation expectation - Several different sources
   a) Difference between the yields on nominal Treasury securities and Treasury Inflation Protected Securities (TIPS).
   b) Other government estimates e.g. federal reserve
   c) Office of the Chief Actuary of the Social Security Administration
12. Coordination of inflation assumptions by actuary and investment consultant.
   a) Discrepancy between the 2 assumptions may be important under ASOP27's consistent economic assumptions
   b) Common approach (i.e. no adjustment to the investment consultant's return forecast or the actuarial assumptions used to project the benefit payments) has 2 potential problems
      i) The expected real return is not reasonable when the actuary's inflation assumption is subtracted from the investment consultant's return assumption.
      ii) The expected return by investment consultants is likely to be different if different inflation is used in the capital markets model. (ok if the difference in assumptions is small)
   c) 2nd approach - Subtract investment consultant's inflation assumption from the expected return to get an expected real return and add that number to the actuary's inflation forecast
      i) Useful if liability is fully or mostly inflation-sensitive
   d) 3rd approach - Plans with fixed-rate or constrained COLA provisions, pay more attention to nominal expected inflation and return
      i) Adjusting the actuarial inflation assumption to be consistent with the inflation assumption in the capital market model
      ii) Potential problems - actuary may need to adjust inflation and salary assumptions more often than is preferred. (Need to adapt experience study to investment consultant's perspective)
   e) 4th approach - investment consultants use actuary's inflation assumption for the capital market forecast.
      i) Though may compromise validity of the investment consultant's methodology)
13. Data to support an assumption for economic growth.
   a) CBO - forecasts of the future 10-year economic outlook for which real GDP growth is one of the fundamental economic variables' assumptions.
   b) Other sources: Bureau of Labor Statistics and the Federal Reserve.
   c) The Office of the Chief Actuary of the Social Security Administration

14. Modeling interest rates and the impact on future returns.
    a) start with forecasting the interest rate environment (U.S. Treasury curve) over the desired horizon.
        i) E.g. 10-year Treasury yields can be the key point on the yield curve for the forecast.
    b) The rest of the curve can be modeled based on historical data or other models.
    c) Set future curves for different credit quality by applying historical credit spreads either as a single spread or with spreads varying by maturity.
15. Fixed income return expectations:
    a) direct calculation or implicit determination based on modeled interest rates.
        i) Forecasting economic fundamentals with capital markets models
        ii) Derive fixed income returns derived from current and future changes in government rates and credit spreads.
16. Return expectations for different credit quality (e.g., Treasury, corporate/credit, high yield).
    a) U.S. Treasury rates are a good starting point. (also see Topic 14)
    b) For non-junk bonds - construct a future corporate or credit yield curve term structure by adding credit spreads for the desired credit quality to the underlying Treasury curve.
        i) Spreads are often based on historical analysis; graded across different maturities.
        ii) Calculate returns based on assumed transition from current yields to the assumed long-term credit/corporate yield curve. (see Topic 15)
    c) For high-yield bonds - consider assumptions on defaults and recovery.
17. Using a dividend discount/dividend growth model to project future equity returns.
    a) The Gordon Dividend Discount Model for assessing future equity return
       $ER = DY + I + RG + \Delta P + \Delta C$
        i) ER—expected return
        ii) DY—dividend yield, sometimes including stock buybacks
        iii) I—inflation
        iv) RG—real earnings growth
        v) ΔP—change in price/earnings ratio
        vi) ΔC—change in currency value for markets not invested in U.S. dollars
18. Inclusion of share buybacks a component of future equity returns.
    a) Can be viewed as another type of dividend or as part of EPS growth
    b) Effect of buybacks is offset when new shares are issued (dilution)
        i) The effect of buybacks is generally net of new issuance.
19. Impact of earnings growth on future equity returns.
    a) Equity returns (ignoring currency impact) driven by
        i) price change
        ii) cash payouts (dividends plus buybacks)
        iii) growth (inflation plus real earnings growth).
    b) Real earnings growth
        i) based on economic forecasts assuming corporate earnings will grow in line with the overall economy.
        ii) cannot be higher than real GDP per capita growth over long periods (though some models will use higher growth rates for shorter-term forecasts)

20. Reflecting P/E ratio changes and the CAPE metric in forecasting equity returns.
    a) P/E ratios go up when market sentiment improves
        i) increasing accumulated returns and decreasing the potential for future returns.
    b) P/E ratios affected by interest rates, market sentiment and other market factors
    c) In the short term, rates often go up when P/E ratios are going up, even though higher rates decrease the value of future earnings cash flow.
        i) I.e. better market sentiment is offsetting the impact of lower rates.
    d) Most common type of P/E ratio for return forecasting is the Cyclically Adjusted Price- Earnings (CAPE) ratio
        i) Smooths out the earnings in the P/E denominator by averaging them over 10 years after adjusting for inflation
        ii) It is important to check whether the definition of earnings has changed due to changes in accounting standards or corporate dividend policies.
        iii) CAPE uses GAAP earnings (historical earnings)—but companies often use pro forma earnings (typically higher than GAAP) The latter are often quoted by media
21. Forecasting returns for equity sub-asset classes.
    a) Dividend discount model - return expectations for equity sub-asset classes would be determined based on yields and P/E levels for those sub-asset classes (see Topic 17).
    b) In some models, higher volatility directly correlated with higher expected returns.
        i) I.e. drive an additional risk premium. – but recently, the view that historical analysis does not justify an additional premium has been gaining acceptance.
22. Adjusting for currency/foreign exchange for non-U.S. assets.
    a) Use relative purchasing power parity (PPP) and interest rate parity (IRP) adjust return forecasts for foreign assets
    b) PPP - exchange rate between two countries is equal to the difference in purchasing power.
        i) Only holds over long-time periods (decades-long time periods), if at all.
        ii) Sometimes used in forecasting model
    c) IRP - currency values will change over time to offset differences in interest rates. - Only holds over short period
    d) Equity returns - Negatively correlated to currency appreciation.
        i) Some investments hedge currency risk - Often used with foreign fixed income investments, but less often with growth assets like equities or real estate
23. Modeling returns for hedge fund investments and other alternative assets.
    a) For hedge fund investments are simply variations on investing in basic asset classes
        i) I.e. Return estimates would correlate to the forecasts for the relevant asset classes.
    b) “Market neutral” or “Absolute return” strategies—try to create return uncorrelated with any market
        i) might rely more heavily on the investment adviser/asset manager assumption\
        ii) may lack strong analytical or empirical support - actuaries might want to use more the more conservative assumptions
    c) Size of the alternative investment vs. entire portfolio may make extensive analysis unnecessary.
    d) Considerations when attempting to classify an alternative and set an appropriate return expectation:
        i) What the underlying holdings within the hedge fund or alternative strategy are,
        ii) What the specific strategy employed by the investment is,
        iii) Whether there is solid actual or back-test information to support a return expectation,
        iv) Whether the expected return been adjusted for fees, and
        v) Whether there is a secondary market for the investment.

24. Expected returns for real estate investments.
    a) expected return for direct real estate investments = current yield + expected growth + change in market value
    b) Yield = net operating income (rental income minus expenses) divided by current market value
    c) Expected return for REITs = current yield + anticipated growth + expected price change
25. Models used to forecast private equity returns.
    a) Difficult due to lack of data.
    b) Impossible to track on daily basis - historical return information does not capture volatility
    c) Private equity return expectations - add an illiquidity premium to the expected return for public equities; and add, for example, 5% to the volatility estimated for public equities.

DURATION AND CONVEXITY FOR PENSION LIABILITIES

1. Duration - good approximations for small interest rate changes
2. When rates are volatile – better to use duration with a convexity adjustment
    a. Give lower duration for rate increases (and vice versa)

1. DURATION

a. for every 100 bp change- liability changes by duration divided by 100 in opposite direction
b. The typical pension plan has a duration of 15
c. Convexity adjustment will give duration < 15 for rate increase (and vice versa)
d. Duration for active members > for retirees
e. Duration for normal cost > for actuarial accrued liability

2. Macaulay Duration

a. A measure of a bond's weighted average cash flows, using yield (y), the time period (t), the number of time periods (n), the annual coupon payment (C), the maturity value (M), and the purchase price (P).

$$\frac{\sum_{t=1}^{n} \frac{tC}{(1+y)^t} + \frac{nM}{(1+y)^n}}{P}$$

3. Modified Duration

a. a measure of the sensitivity of a bond's price to interest rate movements.
b. first derivative of how the price of a bond changes in response to interest rate changes.
c. Can relate to Macaulay Duration where Modified Duration = $\frac{Macaulay\ Duration}{(1+\frac{y}{Payments\ per\ Year})}$

4. **Effective Duration** (use to price bonds with options)

a. Approximates slope of a bond's value as a function of interest rate movements taking the difference in the bond's value (V) for changes in the interest rate (i) by an equal amount ($x = \delta i$) in both directions, and dividing by twice the original value times the interest rate change in each direction.
b. Liability duration measured with Effective Duration, substituting liabilities (L) for the bond's value (V).
c. Effective Pension Liab. Duration = $[L_{i-x} - L_{i+x}]/ [(2) (L_i)(x)]$

5. CONVEXITY

a. Is the second derivative of the change in liabilities for changes in cash flows - Better estimate when rates volatile
b. Estimated pension liability convexity $=[L_{i-x} + L_{i+x} - (2)(L_i)]/ [(2) (L_i)(x^2)]$
c. Convexity adjustment – adjust duration by convexity times interest rate change.

6. NEGATIVE CONVEXITY

a. Most bond Price/yield relationship is Convex

b. If relationship is concave (i.e. negative convexity)
c. Most callable bonds, mortgage backed securities (MBS), and asset backed securities
d. Negative convexity at low rates due to the embedded option
e. Price increase less than non-callable bonds when rates decline
f. Positive convexity at high interest rates (behave like non-callable bonds)

7. KEY RATE DURATION

a. Requires require building a yield curve
b. Suitable for non-parallel yield curve shifts and interest rate changes
c. Considers the sensitivity of a liability's movement to different parts of the yield curve

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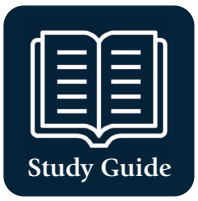

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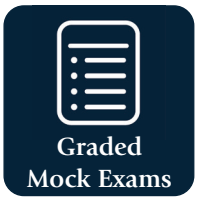

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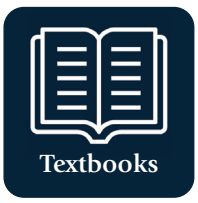

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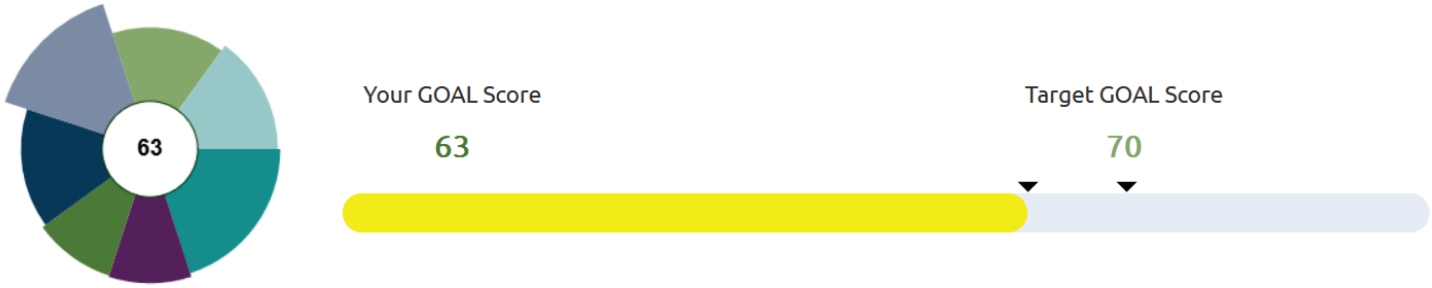

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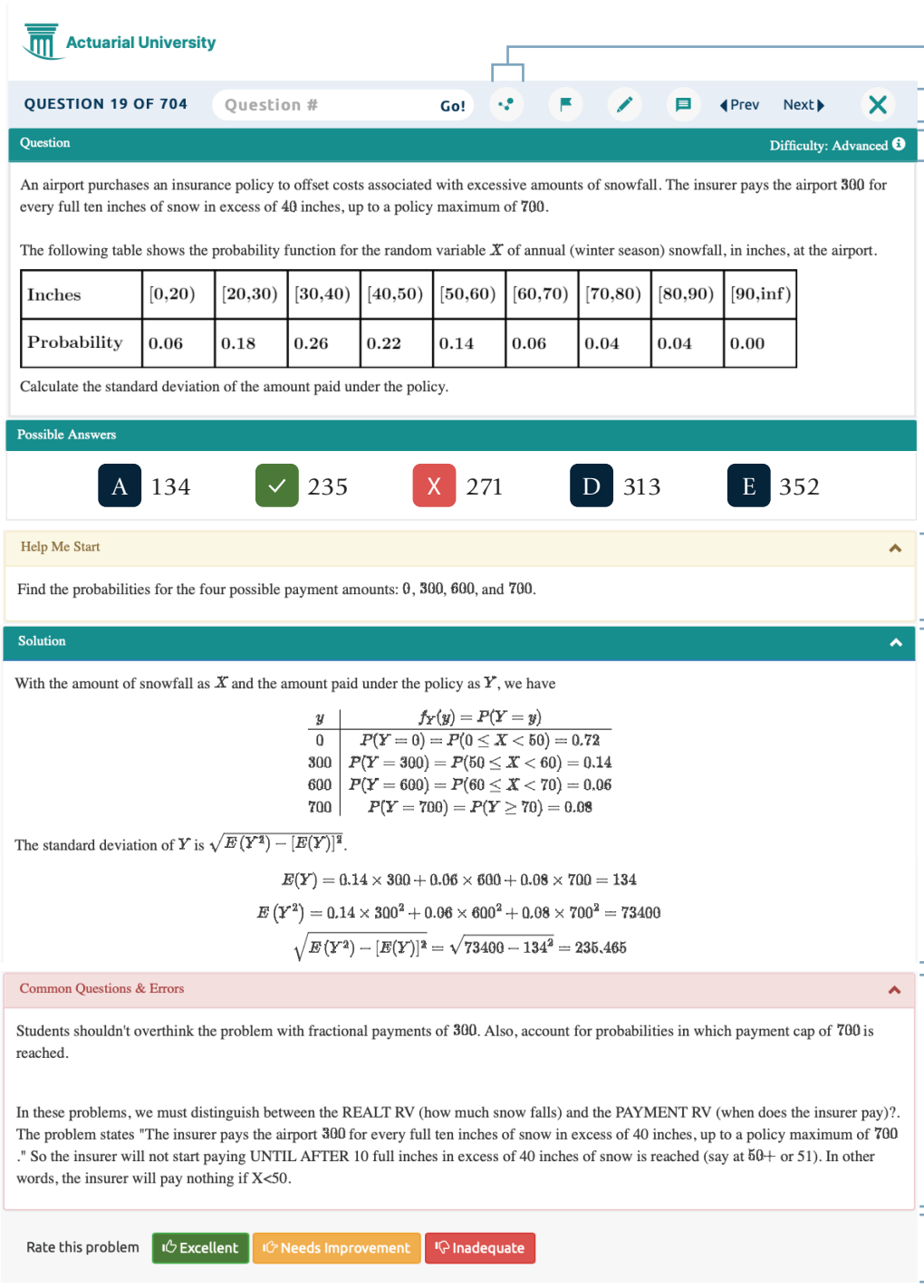

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QUESTION 19 OF 704 | Question # | Go! | Prev | Next

Question — Difficulty: Advanced

An airport purchases an insurance policy to offset costs associated with excessive amounts of snowfall. The insurer pays the airport 300 for every full ten inches of snow in excess of 40 inches, up to a policy maximum of 700.

The following table shows the probability function for the random variable X of annual (winter season) snowfall, in inches, at the airport.

Inches	[0,20)	[20,30)	[30,40)	[40,50)	[50,60)	[60,70)	[70,80)	[80,90)	[90,inf)
Probability	0.06	0.18	0.26	0.22	0.14	0.06	0.04	0.04	0.00

Calculate the standard deviation of the amount paid under the policy.

Possible Answers

A 134 ✓ 235 X 271 D 313 E 352

Help Me Start

Find the probabilities for the four possible payment amounts: 0, 300, 600, and 700.

Solution

With the amount of snowfall as X and the amount paid under the policy as Y, we have

y	$f_Y(y) = P(Y = y)$
0	$P(Y = 0) = P(0 \le X < 50) = 0.72$
300	$P(Y = 300) = P(50 \le X < 60) = 0.14$
600	$P(Y = 600) = P(60 \le X < 70) = 0.06$
700	$P(Y = 700) = P(Y \ge 70) = 0.08$

The standard deviation of Y is $\sqrt{E(Y^2) - [E(Y)]^2}$.

$$E(Y) = 0.14 \times 300 + 0.06 \times 600 + 0.08 \times 700 = 134$$

$$E(Y^2) = 0.14 \times 300^2 + 0.06 \times 600^2 + 0.08 \times 700^2 = 73400$$

$$\sqrt{E(Y^2) - [E(Y)]^2} = \sqrt{73400 - 134^2} = 235.465$$

Common Questions & Errors

Students shouldn't overthink the problem with fractional payments of 300. Also, account for probabilities in which payment cap of 700 is reached.

In these problems, we must distinguish between the REALT RV (how much snow falls) and the PAYMENT RV (when does the insurer pay)?. The problem states "The insurer pays the airport 300 for every full ten inches of snow in excess of 40 inches, up to a policy maximum of 700 ." So the insurer will not start paying UNTIL AFTER 10 full inches in excess of 40 inches of snow is reached (say at 50+ or 51). In other words, the insurer will pay nothing if X<50.

Rate this problem | Excellent | Needs Improvement | Inadequate

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