

 **ACTEX Learning[®]**

RET 201

Retirement Plan

Valuation

Comprehensive

Summary

2nd Edition

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An SOA Exam



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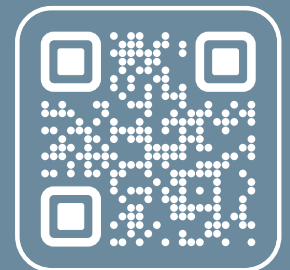
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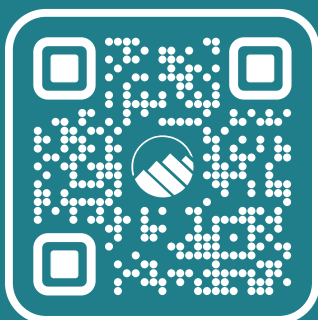
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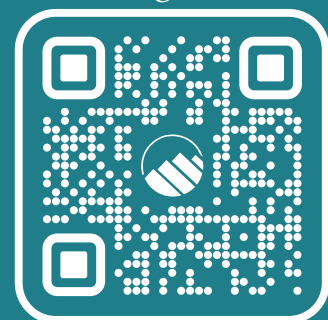
Formula Sheets



Actuarial Exam Tactics



The Actuarial Career:
Getting Started



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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Topic 2

ACTUARIAL ASSUMPTIONS

SELECTING AND DOCUMENTING PENSION ASSUMPTIONS OTHER THAN DISCOUNT RATE, INVESTMENT RETURN AND MORTALITY AAA JUNE 2023

Purpose

1. Provides non-binding guidance on current and emerging practices for selecting and documenting non-discount-rate, non-investment-return, non-mortality assumptions for DB plans.
2. Applies to U.S. tax-qualified and non-qualified, governmental and nongovernmental DB plans where an actuary is subject to ASOPs 27, 35, 4, 25, 41, 51, and 56.
3. Covers measurements assigning costs to periods, liability present values, and cash-flow/obligation projections; excludes individual benefit calculations, benefit statements, and nondiscrimination testing.
4. Explicitly does not address discount rate, investment return, or mortality (covered by separate Academy practice notes).
5. Intended to illustrate possible compliant practices, not to codify “generally accepted practice”; actuaries are not required to follow it.

General requirements for selecting assumptions (ASOP 27 & 35)

1. Key definitions and scope
 - a. ASOP 27 (economic) and ASOP 35 (demographic/other) guide the selection of assumptions for DB plans that are not social insurance programs.
 - b. Measurements include funding valuations, other liability measurements, and cash-flow projections.
 - c. Actuaries must also consider ASOP 56 for actuarial models used in measuring obligations.
2. Prescribed assumptions
 - a. Prescribed by another party: selected by someone else who has authority under law/regulation/accounting rules (e.g., plan sponsor, government for its own plan).

- b. Prescribed by law: mandated directly or chosen from a legally specified range; assumptions chosen by a governmental sponsor for its own plan are not treated as prescribed by law.
3. Reasonable assumption - characteristics
- a. Appropriate for the purpose of the measurement.
 - b. Reflects the actuary's professional judgment.
 - c. Uses relevant historical and current data where reasonably available.
 - d. Reflects estimated future experience, market-implied estimates, or a combination.
 - e. Expected to have no significant bias (not materially optimistic or pessimistic) unless margins for adverse deviation or risk-assessment assumptions are explicitly included and disclosed.
4. Range of reasonable assumptions
- a. Multiple assumptions may be reasonable for a given measurement; different actuaries may choose different reasonable assumptions.
 - b. ASOPs no longer reference a "best-estimate range"; they recognize a range of reasonable methods and assumptions.
 - c. Actuaries must assess the reasonableness of assumptions not selected by the actuary (except prescribed by law or where assessment is not possible).
5. General selection process
- a. Identify types of assumptions needed and relevant factors for each (plan purpose, payment pattern, group status, materiality, volatility).
 - b. Consider:
 - i. Consistency
 - ii. Need for adjustments for adverse deviation or difficult-to-measure provisions (ASOP 4).
 - iii. Trade-off between refined assumptions and materiality/cost of refinement.
 - iv. Use of unbiased rounding, where applicable (ASOP 27 only).
 - v. Events after the measurement date that should inform assumptions as of that date.
 - vi. Data and analyses from plan sponsor, administrator, demographers, economists, and others, synthesized through professional judgment.

Consistency

1. Consistency among assumptions

2. All economic assumptions selected by the actuary should be reviewed for consistency with each other and with demographic/non-economic assumptions, unless immaterial.
3. Consistency is often achieved by using common components (e.g., inflation, economic growth) across assumptions, not by keeping fixed spreads.
4. Change in inflation in one assumption may trigger changes in others; changes driven by unique factors may not require changes elsewhere.
5. Similar consistency requirement for demographic assumptions (ASOP 35): e.g., declining business may affect both turnover and retirement assumptions.
6. Actuaries should also consider consistency with assumptions used for other plans covering the same group, if known, and decide whether inconsistencies are reasonable.
7. Phased-in assumption changes must still be reasonable and consistent at each measurement date they apply.
8. Assumptions and their relationships should be reviewed and updated as appropriate at each measurement date.

Experience analysis

1. Full assumption studies are not required every year; many actuaries perform detailed reviews every 3-5 years for significant assumptions.
2. In between, lighter reviews may compare expected vs actual counts, and liability gains/losses by source, watching for persistent trends indicating the need for change.
3. Analyses should adjust for unusual events (early retirement windows, lump sum offers, workforce reductions, etc.).
4. All assumptions should be checked against evolving expectations (economic, workforce) and longer-period experience; avoid over-weighting non-representative history.
5. For small or low-credibility plans, direct experience comparisons may be less informative, but periodic review against current employer expectations remains important.
6. Special events (plan changes, risk transfers, HR policy changes, pandemics, mergers, major workforce shifts) may warrant additional review and documentation.

Forecast assumptions vs valuation assumptions

1. For forecasts and risk assessments (ASOP 51), actuaries may use multiple assumption sets.
2. A distinct set of valuation assumptions may be selected for each future measurement date (e.g., dynamic 417(e)/430 segment rates rather than current static rates).
3. Separate experience assumptions (e.g., retirement, termination, new entrants) may be used to project the evolving population between forecast dates.

Coordination with ASOP 56 (Modeling)

1. Applies whenever models are used; largely consistent with 27/35 but includes:
 - a. Emphasis on identifying data/assumption responsibilities (only when the actuary is responsible).
 - b. Recognizing a range of reasonable assumptions and using multiple model runs for risk assessment.
 - c. Consistency “where appropriate” for all assumptions used in a model run, including those not selected by the actuary.
 - d. Requirement to consider whether all assumptions remain appropriate when reusing a model.
 - e. Focus on aggregate reasonableness of model output; must disclose if results may be unreasonable due to the combined effect of otherwise reasonable assumptions.
2. Potential gray areas:
 - a. Interpreting “where appropriate” for consistency tests on non-actuary-selected assumptions
 - b. Reconciling ASOP 56 with ASOP 27/35, which do not require consistency checks for non-actuary assumptions; professional judgment is needed.
3. Example gray-area case: the sponsor sets expected return, the actuary sets salary scale; both embed inflation, so ASOP 56 suggests checking consistency, even though ASOP 27 would not require it.

Coordination with ASOP 25 (Credibility)

1. ASOP 25 defines credibility as the predictive value attached to a data set; a credibility procedure evaluates subject experience alone or blends it with other data.
2. ASOP 25 applies when:
 - a. Law requires a credibility evaluation (e.g., plan-specific mortality under IRC 430).
 - b. Actuaries choose to evaluate credibility and state that it has been done per ASOP 25.
 - c. Actuaries blend subject experience with other experience (common for mortality, turnover).
 - d. Actuaries represent data as statistically or mathematically credible.
3. Outside those situations, ASOP 25 does not apply; actuaries may still use plan experience even if not fully credible.
4. When blending experience, relevant external data should have similar risk characteristics (ASOP 12).

5. ASOP 35 emphasizes not giving undue weight to experience that is either not sufficiently credible or not relevant to future expectations (e.g., one-time workforce reductions, pandemic years).
6. SOA's Credibility Educational Resource for Pension Actuaries is cited as a useful reference beyond mortality.

General ASOP 27 process for economic assumptions

1. Identify needed economic assumptions considering purpose, obligation characteristics (pattern, volatility, open vs closed group), and materiality.
2. For each assumption: identify components, evaluate relevant data, consider measurement-specific and general factors, and then select a reasonable assumption.
3. After individual selection, review all economic assumptions for consistency and adjust if needed.
4. Data review should consider both recent and long-term historical data, while avoiding undue reliance where the environment has changed.

Inflation

1. Inflation may be modeled explicitly as its own assumption or implicitly within other assumptions.
2. Relevant data can include:
 - a. Consumer price indices.
 - b. Implicit price deflators.
 - c. Published inflation forecasts.
 - d. Yields on nominal government securities of different maturities.
 - e. Real yields on inflation-indexed government debt.
3. Select and ultimate inflation structures, or regional variations, may be appropriate.

Compensation increase

1. Needed when measuring benefits for active participants with pay-related formulas, except in cases where:
 - a. Unit credit valuation uses the provided current-year expected pay.
 - b. All participants already exceed fixed pay caps.
 - c. Benefits are frozen.
 - d. Measurement is only for accrued benefits at the valuation date.

2. Even then, an assumption for past increases may be required if the data is incomplete.
3. Decomposed into: inflation, productivity/real wage growth, and merit/promotion/longevity.
4. Formats: single flat rate, age/service-graded, or time-varying (by calendar/plan/fiscal year); may include temporary freezes or cuts.
5. May vary by employee category, industry, job, geography, or compensation component (base, bonus, overtime).
6. Data to evaluate: sponsor practices and expected changes, current pay distributions, sponsor and peer history, national wage growth, and productivity.
7. Credibility of sponsor-specific data should be weighed; procedures can be formal or judgmental.
8. Measurement-specific factors: effect of recent bargaining, volatility of variable pay, impending freezes or terminations.
9. Employer-specific adjustments to national data may be limited in duration; long-term assumptions often revert toward broader norms or use select-ultimate patterns.
10. Small owner-dominated plans may use an owner-driven assumption if non-owner impact is immaterial; or separate assumptions for owners vs others.
11. Reasonableness checks: compare to historical individual increases and reconcile expected payroll growth vs modeled payroll given exits and new entrants.

Rate of payroll growth

1. Distinct from the individual salary scale, because new entrants typically differ from exiting employees.
2. Needed for items such as amortization schedules that are level as a percentage of payroll.
3. Often approximated by inflation plus real wage growth, or via explicit projection using salary scale and new-entrant assumptions.
4. Must be consistent, though not necessarily equal, to the compensation increase assumption.

Social Security wage base

1. Typically grows with national average wages, so wage base growth usually $>$ inflation but $<$ employer's own compensation increase assumption.
2. Certain industries may have individual wage growth no higher than the national average, affecting relative positioning.

Growth of individual account balances and conversion factors

1. Required for:

- a. Cash balance or other plans with notional accounts (if rate is not fixed in plan).
- b. Plans where DB benefits depend on an underlying account (e.g., floor-offset).
2. Must reflect the plan-defined interest crediting formula (e.g., bond yields, equity indices, fixed percentages).
3. Future interest rate assumptions are also needed for:
 - a. Converting balances to annuities or among annuity forms.
 - b. Determining minimum lump sums under IRC 417(e)(3).
4. Note: legal restrictions may prevent reflecting certain annuity or lump sum values in specific measurements; the actuary must be aware of these.

COLAs and indexed limits

1. COLA assumptions should mirror the plan's index or formula (e.g., full CPI, partial CPI, caps/floors).
2. For ad hoc COLAs, actuaries should review the sponsor's historical pattern (frequency, amounts) and consider future economic conditions and sponsor health.
3. Inflation-indexed plan limits (e.g., IRC 401(a)(17), 415(b)) should grow if appropriate to the measurement purpose, subject to legal constraints.
4. Some statutes (e.g., IRC 430) may prohibit reflecting future inflation on these limits for certain funding valuations, even though COLAs may be reflected for other measurements (e.g., GAAP).

Floors, ceilings, and other asymmetric provisions

1. For provisions where variance affects benefits asymmetrically, simple expected-value assumptions may be inadequate.
2. Appropriate techniques can include:
 - a. Probability distributions and stochastic modeling.
 - b. Option-pricing methods, either valuing the benefits directly or deriving adjusted assumptions.
3. Examples:
 - a. Floor-offset DB vs DC designs, where DB is a minimum over DC accumulation.
 - b. Lump sum options are defined as the greater of amounts using fixed vs variable interest rates, especially when the variable rate has a meaningful probability of exceeding the fixed rate.

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SELECTING AND DOCUMENTING MORTALITY ASSUMPTIONS FOR MEASURING PENSION OBLIGATIONS, AAA JAN. 2023

Purpose

1. Provides non-binding guidance on current/emerging practices for selecting and documenting mortality assumptions (base tables and improvement) for DB pensions and other post-retirement benefit plans.
2. Applies to U.S. tax-qualified and non-qualified, governmental and nongovernmental plans where the actuary is subject to ASOPs 35, 4, 6, 41, 51, 56, and 25.
3. Covers cost-assignment valuations, actuarial present values, and cash-flow/obligation projections; excludes individual benefit calculations and benefit statements

General ASOP 35 requirements

1. ASOP 35 covers demographic assumptions (including mortality) for DB plans that are not social insurance programs.
2. Measurements include funding valuations, other liability measures, and cash-flow projections, but not individual benefit calculations or nondiscrimination testing.
3. Actuaries must use professional judgment to estimate future outcomes based on past experience and future expectations, then select assumptions accordingly.

Selection process for demographic assumptions

1. Steps (not all required at every measurement date if assumptions remain reasonable):
 - a. Identify types of assumptions needed (e.g., pre-/post-retirement mortality, disabled mortality, beneficiary mortality).
 - b. Consider an “assumption universe” for each type (published tables, plan experience, published studies, expert expectations).
 - c. Choose the assumption format (e.g., age-specific tables, select-ultimate, single rates).
 - d. Select specific assumptions, reflecting plan purpose, design, relevant experience, and factors affecting future experience.
 - e. Ensure selected assumptions are reasonable.

2. Different assumptions may be used for different segments (e.g., blue- vs white-collar, actives vs retirees) when material.
3. When identifying needed assumptions, consider: purpose, plan provisions, pattern of payments, contingencies, materiality, and characteristics of the covered group.
4. Combined contingencies may be modeled with composite assumptions where benefits are equivalent across different exit paths.

Reasonable assumption and range of reasonable assumptions

1. Reasonable mortality assumption must:
 - a. Be appropriate for the purpose.
 - b. Reflect professional judgment.
 - c. Use relevant historical/current data where available.
 - d. Reflect expected future experience and/or market-implied estimates.
 - e. Have no significant bias unless explicit margins for adverse deviation or risk-assessment assumptions are disclosed.
2. There is a range of reasonable mortality assumptions; different actuaries can choose different reasonable assumptions and still comply.
3. ASOP 35 no longer references a “best-estimate range”; focus is on “reasonable” rather than “best estimate.”
4. Actuaries must assess the reasonableness of assumptions not selected by the actuary (except prescribed by law or where assessment cannot be made).

Consistency, review, and experience analysis

1. All demographic assumptions (including mortality) selected by the actuary should be reviewed for consistency with economic assumptions and other demographic assumptions, unless immaterial.
 - a. Example: if the workforce shifts from blue- to white-collar, mortality, turnover, and retirement assumptions may all need adjustment; compensation increase assumptions may also change if the employer becomes more “high-tech.”
2. Actuaries should consider consistency with assumptions used in other plans covering the same group; inconsistencies must be evaluated and adjusted if not reasonable.
3. Phased-in mortality changes must still be reasonable and consistent at each measurement date they apply, regardless of future planned changes.
4. Assumptions and their relationships must be reviewed and updated as appropriate at each measurement date.

5. Experience analysis practices:

- a. Many actuaries perform full mortality experience studies every 3-5 years for significant assumptions, with lighter annual monitoring.
- b. Tests can include comparing expected vs actual deaths and liability gains/losses by source.
- c. One-year deviations do not necessarily imply a change; persistent trends over several years may.
- d. Special events (e.g., plan changes, risk transfers, early retirement windows, pandemics, mergers, workforce contraction/expansion) may trigger additional review.
- e. Actuaries should not give undue weight to experience that is not predictive of the future (e.g., one-time workforce reduction or COVID-affected years).

ASOP 56 (Modeling)

1. Similar to ASOP 35 but emphasizes model-wide consistency, aggregate reasonableness of outputs, and explicit disclosure if outputs may be unreasonable due to combined assumptions.
2. Requires consistency “where appropriate” for all assumptions in a model run, including those not selected by the actuary; professional judgment needed to reconcile with ASOP 35.

ASOP 25 (Credibility)

1. Applies when law requires credibility evaluation, when actuaries explicitly states credibility was evaluated, when blending plan and external experience, or when data are represented as statistically/mathematically credible.
2. Common application: blending plan mortality experience with SOA standard tables using formal credibility methods (e.g., limited fluctuation, Bayesian).
3. Outside those situations, ASOP 25 does not apply, but plan experience may still be used even if not fully credible.
4. Actuaries should avoid undue weight on non-credible or non-predictive experience; when no other relevant experience exists, plan data may be used with lower credibility thresholds.

Base mortality assumption

1. Mortality assumption is typically split into:
 - a. Base table (current-level age/sex/etc, mortality).
 - b. Mortality improvement (past and future).
2. Factors in selecting base mortality table (ASOP 35 §3.4.3)

- a. Differences between employees and retirees (post-retirement mortality often 2-3x employee mortality at the same age).
- b. Size of covered population (small plans may reasonably assume no pre-retirement mortality).
- c. Disabled lives (plan's disability definition and administration; may warrant disabled-mortality tables or adjustments).
- d. Participant subgroups and beneficiaries (e.g., separate tables by gender, collar, blue vs white collar, or other subgroups).
- e. Pre-retirement mortality may be omitted if immaterial (e.g., very small plan, or death benefits equal to actuarial reserve), but this should be justified.

Private-sector tables – Pri-2012

1. Pri-2012 is the latest SOA private DB mortality table family (preceded by RP-2000 and RP-2014).
2. Distinguishes among employees, annuitants/retirees, and disabled lives; differences may or may not be material depending on plan size and benefit forms.
3. Pri-2012 introduced contingent survivor tables based on beneficiary experience after primary participant death; practical use may be constrained by data availability.
4. SOA suggested several approaches for beneficiary mortality in joint-and-survivor annuity calculations under Pri-2012:
 - a. Use retiree mortality, but with beneficiary gender.
 - b. Use retiree mortality while the primary is alive and the contingent survivor table after the primary's death.
 - c. Use a contingent survivor table for beneficiaries both before and after the primary's death.
5. Collar and income:
 - a. White- vs blue-collar differences were found, and collar-specific tables were provided.
 - b. Multiemployer vs single-employer differences were not significant after controlling for collar and income.
 - c. Industry differences were not statistically supported by the data, though actuaries may still reflect industry based on judgment and other evidence.
 - d. Income and benefit levels were significant mortality predictors, but income tables have limitations (e.g., adjustments for form of payment, COLA, frozen plans).

Public-sector tables – Pub-2010

1. Pub-2010 tables are based solely on public sector plan data and have a similar structure to Pri-2012, with important distinctions:
 - a. Separate active tables for teachers, public safety, and general employees; no combined table published.
 - b. For actives, income quartile is generally the most significant explanatory variable, beyond region, year, and job category.
 - c. For annuitants, the job category is significant, with benefit quartile being the most significant predictor across region, year, and category.
 - d. Disabled retirees have separate tables only for public safety.

ASOP 35 requirements for mortality improvement

1. Actuaries must reflect mortality improvement before and after the measurement date; improvement may be positive, negative, or zero.
2. Pre-measurement: adjust base table to reflect improvement from its effective date to measurement date, unless the table is judged to already reflect measurement-date mortality.
3. Post-measurement: include future improvement; uncertainty about magnitude does not justify assuming zero improvement by itself.
4. Non-use of future improvement must be explicitly stated with a rationale.
5. Pre- and post-measurement improvement assumptions may be the same or different; selection can reflect different considerations for historical vs future periods.

Two-dimensional (age \times year) improvement scales

1. Modern scales (e.g., MP-20xx, MIM-2021) are 2-D, built on three core concepts:
 - a. Short-term improvement based on recent experience.
 - b. Long-term improvement rate (LTR) based on expert opinion.
 - c. Smooth transition from short-term to long-term over an appropriate period.
2. SOA RPEC has published annual updates since MP-2014; actuaries can use committee-selected scales or adjust inputs via RPEC models.
3. Example evolution of LTR:
 - a. MP-2014: 1% through age 85, grading to 0.85% at 95 and 0% at 115.
 - b. MP-2020: 1.35% through 62, grading to 1.10% at 80, 0.40% at 95, and 0% at 115.
4. RPEC's selected inputs represent its "best estimate," but involve subjectivity; actual improvements may differ significantly due to medical, environmental, or social changes.

MIM-2021 and other models

1. MIM-2021 is an SOA mortality improvement model intended as a unified framework across practice areas; conceptually similar to RPEC's MP framework but with additional user-defined flexibility.
2. Actuaries may select alternative scales, including custom scales derived from RPEC tools or SSA models, as long as they lie within a reasonable assumption universe.
3. Resources for data and tools include:
 - a. SOA MP-20xx reports and models.
 - b. SSA mortality projections.
 - c. Other demographic studies.
4. RPEC has updated scales through MP-2021 and issued a 2022 mortality improvement update (rather than a new scale) due to COVID-19 impacts.

Documentation and disclosure

1. Mortality assumptions must be disclosed with enough detail for another qualified actuary to understand:
 - a. Base table(s) used and any plan-specific adjustments.
 - b. Pre-measurement adjustment from the table's effective date to the measurement date.
 - c. Post-measurement improvement method and parameters.
2. If no future mortality improvement is assumed for a group or time period, disclosure must explicitly state this and include a rationale.

SELECTION OF MORTALITY ASSUMPTIONS FOR PENSION PLAN ACTUARIAL VALUATION CIA EDUCATION NOTE DECEMBER 2017

Purpose

1. Focuses on two components:
 - a. Base mortality at valuation date (current mortality levels).
 - b. Future mortality improvement scale (prospective changes).
2. Reflects the 2014 CPM Study and the 2017 CIA MI Study, replacing the 2014 educational note.

Credibility and plan size

1. Best-estimate base mortality should reflect: the plan's own experience (if credible), similar plans, socio-economic indicators, and published studies (e.g., CPM).
2. Very large plans ($\approx 10,000+$ retirees):
 - a. Experience studies typically occur every 3-5 years.
 - b. Can customize tables via percentage adjustments by age/sex, or even full plan-specific tables when data are highly credible.
3. Mid-size plans (1,000 – 10,000 retirees):
 - a. Experience is usually not fully credible but still informative.
 - b. Use studies (with credibility weighting) to choose published tables and broad adjustment factors (e.g., 90% or 110% of CPM), possibly varying by age bands.
4. Small plans ($\approx 100+$ retirees):
 - a. Cannot do a full, credible study, but can review mortality gains/losses over prior valuations to identify clear mis-specification or trends.
5. Very small plans (few retirees):
 - a. Rely mainly on appropriate published tables, adjusted for membership characteristics where warranted.
6. If plan experience is not fully credible, actuaries should also consider socio-economic indicators (pension size, collar, industry, etc.) using comparable external data.

Experience analysis

1. Weighting:
 - a. Benefit-weighted (or liability-weighted) experience is generally preferred to headcount, except in flat-benefit or frozen plans where headcount can be appropriate.
2. Base year effects:
 - a. For fully generational tables, no gain/loss suggests the table reflects current levels; future improvement sufficiency will show up over time.
 - b. For static tables projected k years (e.g., 10) with Scale AA, no gain/loss implies experience is already at the projected level, meaning the projection margin has eroded and the table is outdated.
3. Basis of comparison:
 - a. When comparing to a published table (e.g., CPM2014), match methodology: same benefit weighting, same inclusion/exclusion rules (e.g., CPM excludes surviving spouses).
4. Workforce evolution:
 - a. Current pensioners reflect the workforce decades ago; actuaries should consider whether the current workforce has different longevity characteristics than historical cohorts.

Published mortality studies

1. 2014 CPM Study (Canadian pensioner mortality):
 - a. First broad experience study for Canadian pension plans (public and private).
 - b. Provides CPM2014 (combined), CPM2014Publ (public), CPM2014Priv (private).
2. New information:
 - a. CIA and SOA committees monitor experience; actuaries should consider new studies and trends, preferring Canadian pension plan data when available.
3. Older tables (UP94, GAM94, RP-2000 + Scale AA):
 - a. CPM shows the current Canadian pensioner mortality is significantly lower and with a different shape than these.
 - b. Using UP94/GAM94/RP-2000 + AA as the best estimate is only appropriate if strongly supported by credible plan-specific or other quantitative evidence.
4. Generally inappropriate for pension base mortality:
 - a. General population tables (e.g., Canada Life Tables) due to material differences between the general population and pensioners; can be used only for geographic differentials.

- b. Individual annuitant tables (anti-selection risk) except perhaps for very small or individual pension plans.

Adjustments for plan membership characteristics

1. Mortality is systematically higher:
 - a. Blue-collar vs white-collar.
 - b. Private-sector vs public-sector.
 - c. Small pensions vs large pensions.
2. If plan characteristics \approx composite CPM dataset and there is no credible evidence to the contrary, no adjustment may be needed.
3. If a plan has a fully credible benefit-weighted experience, the plan-level table already reflects membership characteristics; further published adjustment may not be needed.

Key dimensions and issues

1. Sector (public/private):
 - a. Sector alone is imperfect; subgroups (e.g., blue-collar public workers) may differ from the overall public sector; judgment needed.
2. Collar type:
 - a. CPM does not provide collar-specific tables; some U.S. studies do.
 - b. Combining collar adjustments from one study with CPM may be problematic due to differing demographics; apply with caution.
3. Industry:
 - a. Industry-level results are mixed and often not fully credible; CPM published A/E ratios by industry and age, but not full tables.
 - b. Adjustments may be considered only when industry shows credible, significant deviation vs average (larger, homogeneous groups such as teachers may have better data).
4. Pension size/socio-economic status:
 - a. Can adjust via size factors or separate tables by pension/salary bands.
 - b. Size is a proxy for socio-economic status (correlation, not causation); design changes (e.g., freezes) that shrink DB amounts do not necessarily change socio-economic status.
 - c. Relevant metrics may include pension per year of service or salary, not just gross pension.

- d. Adjustments are most useful when a plan's size distribution differs materially from that underlying CPM tables.
 - e. Single benefit-weighted size factor per gender is often used as a practical approximation.
 - f. When applying size adjustments, align with base year and methodology of size factors (e.g., treatment of indexation for indexed vs non-indexed pensions).
 - g. Typically, the same size adjustment factors are applied to survivors and to actives/deferreds where demographics are stable.
5. Other socio-economic proxies, e.g., postal code, education level, may be used where credible data exist.
 6. Combining multiple adjustments:
 - a. Combining collar, industry, sector, and size adjustments mechanically may over/understate effects; better to analyze each dimension separately and then choose an overall adjustment within the resulting range.
 7. Graduation:
 - a. After applying adjustments or building plan-specific tables, rates may need smoothing ("graduation") to ensure reasonable age-to-age patterns.

Future mortality improvement methods

1. Improvements have occurred historically and are expected to continue, but future rates are uncertain and typically studied using general population data (e.g., CPP/QPP).
2. Best-estimate improvement structure usually has three parts:
 - a. Short-term rates from recent history.
 - b. Ultimate long-term rates (highly uncertain).
 - c. Transition pattern between them (by age and calendar year, possibly cohort).
3. Common implementation methods:
 - a. 2-D generational scales (age \times year), e.g., CIA MI-2017, CPM-B.
 - b. 1-D generational scales (age only), e.g., CPM-B1D2014, Scale AA.
 - c. Static tables with fixed projection period (now discouraged except as an approximation).

Future mortality improvement scales

1. Two-dimensional generational scales
 - a. MI-2017: based on Canadian general population data 1967-2015, combining experience and expert judgment on short-term, ultimate rates, and transition.
 - b. CPM-B: based on CPP/QPP Study and CPP actuarial report assumptions (data 1967-2007).
 - c. Both are recent, Canada-specific, and generally appropriate in the absence of credible contrary information.
 - d. Other 2-D scales with different short/ultimate rates or transition patterns may also be acceptable if well-justified.
2. One-dimensional scales
 - a. Historically common; simpler but less robust than 2-D.
 - b. CPM-B1D2014 was designed as a reasonable approximation to CPM-B for valuations in 2014-2015.
 - c. 1-D scale may still be acceptable:
 - i. When it reasonably approximates the financial impact of an appropriate 2-D scale.
 - ii. When actuaries believe short-term and ultimate rates are essentially equal (no transition needed).
3. Static projection with fixed period
 - a. Historically used as a computational shortcut; generational scales are now preferred.
 - b. Shortcomings:
 - i. May misstate current service cost and liability allocation by cohort/membership class.
 - ii. Requires frequent updating as base tables and liability duration change.
 - iii. If used, actuaries must ensure results remain acceptable for their purpose and recognize duration differences (service cost vs accrued liability, actives vs pensioners).
4. Review of improvement assumptions:
 - a. Emerging Canadian pensioner improvement trends and new studies should be monitored; when past improvement deviates from expectations, base tables may need updating.
 - b. Adjustment for future improvement is conceptually separate from calibrating current levels; both must be reviewed.

Pre-retirement mortality

1. Pre-retirement mortality often has a limited impact because:
 - a. Mortality at younger ages is low.
 - b. Death benefits often equal the commuted value of a deferred pension.
2. In many cases, using the same table as for post-retirement is adequate for pre-retirement.
3. Extra care is needed if:
 - a. Death benefits differ materially from commuted values.
 - b. Observed active mortality differs significantly from standard tables.
4. Very small plans may reasonably assume no pre-retirement mortality, especially where death benefits equal commuted value.

Disabled life mortality

1. Disabled lives have significantly higher mortality than non-disabled; plans may warrant a separate disabled mortality assumption if data and plan design justify it.
2. When introducing a separate disabled table, adjust the non-disabled retiree table if the standard table originally reflected combined disabled + healthy retiree mortality.

Sensitivity analysis

1. Sensitivity disclosure may be appropriate depending on engagement or intended use.
2. Typical measures:
 - a. Change in current service cost/normal cost.
 - b. Change in actuarial liabilities/accounting obligations/PV of accrued benefits.
3. Example sensitivity methods:
 - a. Life expectancy +1 year (often implemented via age setback).
 - b. Uniform % change in mortality rates (e.g., -10% at all ages), with optional disclosure of resulting change in life expectancy.
4. For improvement, sensitivity can be shown by adjusting ultimate rates and transition patterns consistent with underlying studies.

Application and subsequent developments

1. Pension mortality assumptions are often reused for other actuarial purposes (e.g., OPEB, executive comp), but actuaries must consider differences in provisions, population, and liabilities; best- estimates for other plans may require different assumptions.
2. New experience studies are “subsequent events” that provide information about the entity as of the valuation date; if issued before the report is substantially complete, they should be reflected in the mortality assumption.
3. If a report was issued before a new study, the actuary must decide whether to amend or withdraw the report.
4. Guidance does not remove the need for judgment and reasonable approximations; assumptions must be independently reasonable under the Standards.

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FORECASTING INVESTMENT RETURNS AND EXPECTED RETURN ASSUMPTIONS FOR PENSION ACTUARIES AAA FEB 2019

Purpose

1. Describes current and emerging practices for forecasting investment returns and setting expected return assumptions for pension work (funding, accounting, solvency projections, ALM).
2. Intended for actuaries relying on external capital market assumptions (CMA) or developing their own, and for discussions with investment professionals.
3. Not an ASOP, not binding, not a definitive statement of generally accepted practice, and may become obsolete as markets/practices evolve.
4. Applies to funded U.S. benefit plans and investment return assumptions only; does not cover other economic or demographic assumptions.
5. Relevant professional guidance includes: ASOP 27 (economic assumptions for pensions), ASOP 23 (data quality, including derived data), and ASOP 41 (actuarial communications).
6. Code of Professional Conduct and U.S. Qualification Standards also apply to selecting/recommending investment return assumptions.

Internal rate of return (IRR)

1. IRR is the rate that sets NPV of all cash flows (including initial outlay) to zero; in pensions, it is the discount rate equating benefit payments to their present value.
2. Bond yields are IRRs that equate coupons plus redemption to current price; these yields anchor expected fixed-income returns.
3. IRR-type models also underpin expected returns for equities (via dividend/profit cash flows and the Gordon Growth Model), real estate, and high-yield credit.

Mapping asset allocation and asset classes

1. Capital market models define asset and sub-asset classes differently; mapping actual portfolios to model classes requires judgment and may involve overlapping categories (e.g., U.S., international, global equity).

2. Use benchmarks (from performance reports or prospectuses) to map funds to model sub-asset classes when no perfect match exists.
3. Example mappings: all-cap U.S. index → U.S. large cap; mid-cap fund → either small cap or 50/50 large/small; small-cap value → small cap; European SMID → international equity; global developed large cap → roughly 50% U.S. large, 50% international.
4. International small-cap funds are typically mapped to international equity because geography is more important than size for forecasting.
5. Hedge funds/derivatives are often hardest to map; when strategy is clear, they may be slotted into equity/fixed-income/real assets, otherwise, manager-provided return estimates may be used.

Common equity, fixed income, and alternative sub-asset classes

1. Equity sub-classes include: U.S. equity (all listed U.S.), large cap (> about \$5B), small cap (< about \$1B), mid cap (\$1-5B), global equity, international, developed ex-U.S., and emerging markets.
2. Fixed-income sub-classes include: U.S. Aggregate (Treasury, IG corporate, MBS, ABS), high yield (< BBB/Baa), short duration, long gov/credit, intermediate corporate, international, hedged international, world bonds, and emerging market debt.
3. Alternative “real asset” classes: real estate, direct real estate, REITs, European real estate, global infrastructure, farmland.
4. Other alternatives: private equity, hedge funds (various strategies), global macro hedge funds, commodities, and specific commodity exposures such as oil.

Actual vs target allocation and anticipated changes

1. Investment Policy Statement (IPS) typically specifies permitted asset classes and target ranges; expected return is often based on this structure plus actual holdings.
2. If actual holdings match IPS, the expected return typically uses the current allocation unless a known future change will occur.
3. If no IPS, actual allocation drives expected return; if changes are anticipated, an average allocation over time may be used.
4. When actual allocation differs from IPS, assess whether the difference is temporary or permanent; use target allocation if temporary, actual if permanent.
5. IPS may only specify broad classes (e.g., total equity 40-75%); actuaries can use actual holdings to determine sub-asset class weights for the CMA model.

Future allocation shifts

1. Asset mixes may change due to phased-in strategies, maturing plan demographics and liquidity needs, dynamic derisking (funded-status triggers), or gradual moves into/out of illiquid classes such as private equity.
2. For “single-date” measurements (e.g., public/multiemployer AAL, ASC 715 pension expense), it is usually considered appropriate to ignore future allocation changes.
3. For multi-period uses (e.g., contribution budgeting, long-term projections), it may be appropriate to reflect anticipated allocation changes, subject to rules for specific funding/accounting frameworks.
4. Three approaches to reflecting changes: one blended expected return (single rate), select-and-ultimate assumption (different rates by period), or basing expected return purely on the future allocation.
5. Blended rate approach weights current and future expected returns by timing of allocation changes and plan cash flows (e.g., 7.5% now, 7.0% later → chosen single rate between them).
6. Select-and-ultimate structures can accommodate a one-time shift (e.g., after 3 years) or a series of step-downs as a plan matures and moves into more fixed income and cash.
7. In some cases, the ultimate allocation (e.g., after a large move into private equity) is considered most relevant, so the current mix is effectively ignored.

Volatility, correlations, and arithmetic vs geometric returns

1. Asset-class CMA outputs may be expressed on arithmetic or geometric bases; portfolio expected geometric return is always lower than arithmetic due to volatility drag.
2. Portfolio arithmetic return is typically the allocation-weighted average of asset-class arithmetic returns.
3. Geometric (compound) return depends on the joint return distribution, asset-class correlations, serial return relationships across years, and the time horizon.
4. Under lognormal, IID assumptions, the portfolio standard deviation is computed using asset-class volatilities and correlations, and a closed-form link from arithmetic mean and standard deviation to long-run geometric mean is used.
5. Example: 60/40 portfolio with 8.0%/3.5% arithmetic returns, 17%/6% standard deviations, and 20% correlation yields about 6.2% arithmetic and 5.6-5.64% geometric return.
6. A common approximation is $\text{geometric} \approx \text{arithmetic} - \frac{1}{2} \times \text{variance}$ (using portfolio standard deviation squared).
7. More sophisticated approaches use stochastic models with richer distributions, serial correlation (mean reversion), changing CMAs, and dynamic correlations; the median of simulated geometric returns over the horizon is used as the “expected” geometric return.

Historical data and Investment Policy Statement (IPS) targets

1. Historical averages alone are weak predictors of future returns; more useful is decomposing returns into components (yields, P/E, earnings vs GDP, inflation) and comparing current values to history.
2. Volatility and correlations are often estimated primarily from history, ideally over full market cycles (bear, recovery, bull) spanning roughly 5-20 years.
3. Applications of historical data include: mean reversion of returns/interest rates toward historical averages, though the future environment may differ in growth, demographics, globalization, monetary policy, and payout behavior.
4. Historical risk premiums can be added to current or projected risk-free yields (e.g., equity premium over the 10-year Treasury), often within a building-block structure: inflation + real risk-free + term premium + equity premium.
5. Historical market data supports regression-type analyses to identify relationships (e.g., between private and public equity) and to define “normal” yield curve shapes.
6. Some models deliberately avoid historical returns as primary inputs; greater sophistication tends to rely more on forward-looking indicators and decompositions than on raw historical return means.
7. IPS “target return” is a simple but weak method; it may ignore current market conditions and might represent aspirational or minimum goals, not realistic expectations, so further analysis is needed.

Time horizon and term structure of expected returns

1. Fixed-income returns are relatively predictable over horizons near the instruments’ maturity/duration; equity returns are less predictable, but 10-20-year equity returns show a relationship to starting P/E (or similar valuation ratios).
2. As the horizon extends beyond about 15-20 years, current valuations and yields become less informative, and long-run fundamentals (e.g., sustainable economic growth) gain importance; transition from current to equilibrium conditions must be specified.
3. Because returns may differ by period, two plans with identical asset allocation but different benefit-payment patterns can have different effective discount rates.
4. Cash flows over the next 10 years often represent 40-50% of the liability for many public/multiemployer plans, so near-term return expectations heavily influence liability values.
5. Forecasts frequently assume mean reversion in valuations/yields (e.g., P/E or bond yields drifting toward historical averages over 10 years), which produces a term structure of expected returns: lower returns when valuations are high/yields low, higher expected returns after reversion.

6. Select-and-ultimate return assumptions can align period-specific expected returns with each benefit payment; alternatively, a single equivalent discount rate may be derived, which can differ across plans with the same asset mix but different maturity profiles.

Inflation assumptions and consistency with investment capital market assumptions (CMAS)

1. Market-based inflation expectations can be approximated by breakeven inflation (nominal Treasury yield minus TIPS yield) for 10-, 20-, and 30-year maturities, published by the Federal Reserve.
2. Other inflation sources include: Federal Reserve's explicit 2% PCE inflation objective, Cleveland Fed's term-structure inflation forecasts, CBO's 10-year outlook, and SSA Office of the Chief Actuary's OASDI Trustees Report (inflation and real GDP).
3. Under ASOP 27, economic assumptions should be consistent; if the actuary's inflation assumption differs from that embedded in the investment consultant's CMA, the impact on real vs nominal returns and liabilities must be considered.
4. For fully inflation-sensitive plans (final-salary plus full COLA), the real return is more crucial; nominal inflation and nominal return levels matter more for plans with capped or fixed COLAS.
5. Coordination methods include:
 - a. Making no adjustment (simple but may produce unreasonable real returns or inconsistent CMAs if inflation assumptions differ significantly).
 - b. Backing out the consultant's implied real return (consultant nominal return minus consultant inflation) and recombining this with the actuary's inflation assumption.
 - c. Adjusting the actuary's inflation and related assumptions (payroll, salary scale) to match the consultant's inflation, which improves consistency but can be operationally cumbersome.
 - d. Requesting that the consultant adopt the actuary's inflation assumption, which can provide theoretical consistency but may conflict with the consultant's methodology or practical constraints.

Economic growth, interest rate modeling, and fixed-income returns

1. Real GDP growth, together with inflation, underpins long-term CMAs; higher growth is associated with higher interest rates and earnings growth, linking macro assumptions to asset returns.
2. Data sources for growth assumptions include CBO's 10-year outlook, Bureau of Labor Statistics, Federal Reserve supervisory scenarios, and SSA OACT'S OASDI economic assumptions.

3. Interest-rate modeling typically starts with the U.S. Treasury curve, often focusing on the 10-year as an anchor, with mean-reverting processes used for long-term projections.
4. Yield-curve slope and curvature (e.g., 1-10-30-year relationships) can be modeled from historical CMT data; credit spreads are layered on top to derive non-Treasury curves by credit quality and maturity.
5. Rising rates lower the prices of financial assets and can depress returns over rising-rate periods, though equity responses are less straightforward due to growth and sentiment effects.
6. Modern CMAs generally derive fixed-income returns implicitly from modeled rate and spread paths, rather than from simple static yield assumptions.
7. For individual bonds held to maturity, current yield is a good indicator of return over a horizon similar to maturity; for bond portfolios with constant duration, long-run returns tend toward the initial “rolling yield” over a horizon roughly double the duration.
8. Direct-yield methods work reasonably for horizons tied to duration/maturity, but for materially different horizons, modeling rates/spreads and applying duration-sensitive return formulas is preferred.
9. Credit-quality-specific returns (Treasury vs investment-grade credit vs high yield) are typically modeled by adding credit spreads to Treasury curves, allowing for the term structure of spreads and incorporating defaults/recoveries for high-yield.

Equity return models, buybacks, growth, and valuation effects

1. Dividend discount (Gordon) models decompose equity returns into cash payouts and growth, plus changes in valuation multiples and currency where applicable.
2. Basic equity expected-return decomposition: $ER = \text{dividend yield (including buybacks)} + \text{inflation} + \text{real earnings growth} + \text{change in P/E} + \text{currency effect (for non-USD assets)}$.
3. Dividend yield is observable; buybacks are economically similar to dividends (cash payout via reduced share count) and should be incorporated, net of new issuance/dilution, when estimating payouts.
4. Dividends have declined as a payout mechanism, while buybacks have grown in importance; data on buybacks is less accessible, especially outside the U.S.
5. Real earnings growth is generally anchored to economic growth, with empirical evidence suggesting it cannot exceed real GDP per capita indefinitely; models may allow higher near-term growth than long-term sustainable levels.
6. Changes in P/E ratios map directly into returns (e.g., a 2% increase in P/E adds approximately 2% to total return over that period), and CAPE (cyclically adjusted P/E) is often used to gauge starting valuations for long-term forecasts.

DURATION AND CONVEXITY FOR PENSION LIABILITIES

1. Duration formulas are good approximations for pension liability changes when interest rate changes are small.
2. Because interest rates can be volatile, adding a convexity adjustment gives a more accurate estimate of liability changes.
3. With convexity, duration is lower for interest rate increases and higher for interest rate decreases.

Basic relationships and typical values

1. Pension liabilities, such as bonds, move inversely with interest rates:
 - a. Rate $\uparrow \Rightarrow$ liabilities \downarrow .
 - b. Rate $\downarrow \Rightarrow$ liabilities \uparrow .
2. Rule of thumb: for every 100 bp change in rates, liability changes by (duration \div 100) in the opposite direction.
3. Typical single-employer pension plan:
 - a. Overall duration \approx 15.
 - b. With convexity:
 - i. Duration $<$ 15 for rate increases.
 - ii. Duration $>$ 15 for rate decreases.
4. Segment-specific durations:
 - a. Active participants' liability duration $>$ retired participants' duration.
 - b. Normal Cost (NC) duration $>$ Actuarial Accrued Liability (AAL) duration.

Macaulay duration

1. Measures the weighted average time to receive a bond's cash flows.

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

- a. Yield (y)

- b. Time period (t)
- c. Number of periods (n)
- d. Annual coupon payment (C)
- e. Maturity value (M)
- f. Purchase price (P)

Modified duration

- 1. Measures price sensitivity of a bond to interest rate movements.
- 2. Equal to the first derivative of price with respect to interest rates.
- 3. Relationship: Modified duration = Macaulay duration adjusted for the yield compounding frequency.

$$= \frac{\text{Macaulay Duration}}{\left(1 + \frac{y}{\text{Payments per Year}}\right)}$$

- 4. Interpreted as percentage price change per unit change in yield (ignoring convexity).

Effective duration (bond and pension application)

- 1. Designed for bonds with embedded options, where cash flows can change with interest rates.
- 2. Approximates the slope of value vs interest rates using symmetric shocks:

$$= \frac{V_{i-x} - V_{i+x}}{(2)(V_i)(x)}$$

- 3. Pension liability application:

- a. Replace bond value V with liabilities L

$$\frac{L_{i-x} - L_{i+x}}{(2)(L_i)(x)}$$

- b. Effective duration of liabilities uses the same structure: change in L from up/down rate shocks around the current rate.

Numerical example: duration without convexity

- 1. Liability values at three spot rates (illustrative):
 - a. 4%: 1,160,000.
 - b. 5%: 1,000,000.

- c. 6%: 860,000.
2. Duration = $(1,160,000 - 860,000)/(2 * 1,000,000 * 0.01) = 15$
3. Using duration ≈ 15 as an approximation for a typical plan:
 - a. 100 bp increase:
 - i. Liability multiplier $\approx 1 - 0.15 = 0.85$.
 - ii. New liability $\approx 85\%$ of the original.
 - b. 100 bp decrease:
 - i. Liability multiplier $\approx 1 + 0.15 = 1.15$.
 - ii. New liability $\approx 115\%$ of the original.
4. Use compounding, not simple linear scaling, for non-100 bp moves:
 - a. 50 bp (0.5%) increase:
 - i. Treat as half of 100 bp \Rightarrow liability $\approx \sqrt{0.85} \approx 92.20\%$ of the original.
 - b. 50 bp decrease:
 - i. Liability $\approx \sqrt{1.15} \approx 107.24\%$ of the original.
 - c. 200 bp increase:
 - i. Liability $\approx (0.85)^2 \approx 72.25\%$ of the original.
 - d. 200 bp decrease:
 - i. Liability $\approx (1.15)^2 \approx 132.25\%$ of the original.
5. These estimates remain useful even outside the initial “corridor” (e.g., 4-6%), as long as the duration and convexity assumptions are reasonable.

Convexity

1. Traditional pension duration approximations ignore convexity.
2. Convexity is the second derivative of value (or liability) with respect to interest rates.
3. Key empirical pattern:
 - a. Rate decreases often cause larger liability increases than the liability decreases caused by equal-sized rate increases.
4. Adding convexity to duration:
 - a. Improves accuracy under significant interest rate volatility.
 - b. Better reflects the curvature of the liability vs rate relationship.

5. Pension liability convexity can be approximated using a formula that parallels the effective duration formula, using multiple rate points.

Duration with convexity adjustment

1. General idea:
 - a. Adjust duration estimate by a term involving convexity and the size of the rate change.
 - b. Duration =
$$\frac{L_{i-x} + L_{i+x} - (2)(L_i)}{(2)(L_i)(x^2)}$$
2. Practical implication:
 - a. For rate decreases, adjusted duration is higher than baseline duration.
 - b. For rate increases, adjusted duration is lower than baseline duration.

Convexity example

1. Example assumptions:
 - a. Base duration = 15.
 - b. Convexity = 100.
 - c. Rate shock magnitude = 1% (100 bp).
2. Adjusted durations:
 - a. For rate decrease: $15 + 100 \times (1\%) = 15 + 1 = 16$.
 - b. For rate increase: $15 - 100 \times (1\%) = 15 - 1 = 14$.
3. Resulting liability sensitivities for a 100 bp change:
 - a. Rate decrease:
 - i. Liability increase $\approx 15\% + 1\% = 16\%$. (Or via formula $15\% + 100 \times (1\%)^2$)
 - ii. Example check: from 5% to 4%, AAL from 1.00 to 1.16 million (16% increase).
 - b. Rate increase:
 - i. Liability decrease $\approx 15\% - 100 \times (1\%)^2 = 15\% - 1\% = 14\%$.
 - ii. Example check: from 5% to 6%, AAL from 1.00 to 0.86 million (14% decrease).
4. Using different durations for up vs down shocks materially improves estimate accuracy versus using a single symmetric duration.

Negative convexity

1. Most standard (non-callable) bonds have positive convexity: the price-yield curve is bowed outwards.
2. When the price-yield graph is concave, the instrument has negative convexity.
3. Securities with negative convexity at low rates typically include:
 - a. Callable bonds.
 - b. Mortgage-backed securities (MBS).
 - c. Asset-backed securities (ABS).
4. With negative convexity at low rates:
 - a. As rates fall, prices increase more slowly than for straight (non-callable) bonds, due to options likely being exercised or prepayments accelerating.
 - b. At high rates, callable bonds revert to positive convexity similar to option-free bonds (call is out of the money).
5. The article's figure (Vanguard source) illustrates:
 - a. A convex price-yield curve for positive convexity.
 - b. A flatter, concave curve for negative convexity when rates fall.

Key rate duration

1. The duration and convexity described earlier apply to parallel yield curve shifts.
2. Key rate duration splits overall interest rate sensitivity across specific maturities on the yield curve.
3. Uses:
 - a. Measures how liabilities respond when different parts of the curve move differently (non-parallel shifts).
 - b. More accurate for realistic yield curve movements that are not purely parallel.
4. Implementation requires:
 - a. Building a yield curve from market instruments.
 - b. Shocking one key point (e.g., 1-year, 5-year, 10-year) at a time while holding others constant, and revaluing liabilities to obtain separate key rate durations.

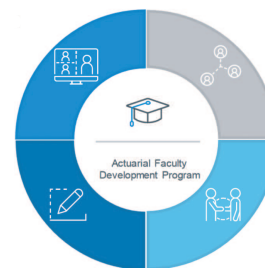
Overview of The Actuarial Faculty Development Program

The AFDP is a pilot program developed by ACTEX to strengthen actuarial teaching staff in low-middle income countries with a program of live virtual classes and education resources. This program is supported by the UNDP-Milliman Global Actuarial Initiative (GAIN).

Actuarial Education Bootcamp

Virtual live lectures focused on:

1. Actuarial Science Program Development
2. Insurance principles and the actuarial profession
3. Technical actuarial skills
4. Actuarial Pathways
5. Professionalism and Ethics



Curriculum Resources

Recommendations for curriculum and access to resources to provide in the classroom:

1. Open access to digital resources provided through the Bootcamp
2. Academic GOAL bundles including student access for one academic year

Community of Practice

Online platform for members of the program to pose questions, interact with international community of actuarial science faculty, and receive inspiration.

Mentorship

Direct mentorship with experience university faculty to provide ongoing support.

ACTEX Academic GOAL Bundles

As part of the program, the participants will have access to ACTEX Academic GOAL bundles for the duration of the program (1 academic year). ACTEX Academic GOAL provides instructional videos, textbooks and manuals, as well as an actuarial science database of hundreds of questions to both students and teachers, equipping them with additional teaching content.

Benefits of Academic GOAL

- Allows editing capabilities to customize any question or solution(s)
- Build course assignments effectively
- Automated grading (for Multiple Choice questions) with autonomy to when grades and solutions are released to students
- Simple enrollment with one shared access code per class
- Analyze performance in multiple ways – by student and/or assignment

ACTEX Academic GOAL Resources

- Digital access to textbook or study manual (choice of instructor) covering entire syllabus with step-by-step explanations of concepts as well as hundreds of examples exercises
- Academic GOAL database for assignments and student independent study
- Instructional video library for independent study or flip classroom options
- Flashcards and formula sheets to support student exam prep
- Academic Resource Center providing centralized online resource library
- Access to Actuarial University which includes hub of definitions and access to student forums

Key Highlights of The Actuarial Faculty Development Program

Program Cost

An estimated fee of:

- \$375 early bird registration
- \$675 regular admissions

Participant will be charged by ACTEX for the participation in this program. The fee is used to offset operational costs (including the development of program, learning portal and royalties of study materials) involved in administering the program.

Bootcamp Instructors

- Volunteer actuarial practitioners from Milliman GAIN and other companies
- Professors with extensive actuarial science teaching experience
- ACTEX eLearning specialists

Certificate

At the end of the program, the participants will receive a certificate recognizing their participation.

How You May be Able to Support

Encourage and support academic staff at your university to participate in the AFDP. If you are an academic staff and would like to participate in this program, please contact us to get in touch with you.

Support as a Volunteer to:

- Sponsor a participant to cover their program cost to support faculty and student development
- Teach the live virtual classes for the Bootcamp
- Develop course materials
- Become a mentor / community champion in the CoP
- Provide resources and reference teaching materials / curriculum.



Talk to Us

Reach out with any questions!

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Josh Collins josh.collins@milliman.com

Program Duration

The Bootcamp Component will be 6 months with the program set to run for 1 year per cohort. This period includes access to a community of practice, curriculum resources and mentorship directly provided and organized by the program.

Program Structure

Fully Virtual

Size of Cohort

Minimum 5, Maximum 25

Program Timeline

- April – Early bird enrollment of participants
- May to June – Regular enrollment of participants
- July – Live teaching component commencing
- Following June – Cohort graduation

