SOCIETY OF ACTUARIES®

2019 ANNUAL MEETING & EXHIBIT

October 27-30
Toronto, Canada

Session 087: Cashflows: A New Dimension

2019 ANNUAL MEETING
& EXHIBIT

Cashflows: A New Dimension

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SOCIETY OF ACTUARIES®

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- Do not discuss what you or other entities plan to do in a particular geographic or product markets or with particular customers.
- Do not speak on behalf of the SOA or any of its committees unless specifically authorized to do so.
- Do leave a meeting where any anticompetitive pricing or market allocation discussion occurs.
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Adherence to these guidelines involves not only avoidance of antitrust violations, but avoidance of behavior which might be so construed. These guidelines only provide an overview of prohibited activities. SOA legal counsel reviews meeting agenda and materials as deemed appropriate and any discussion that departs from the formal agenda should be scrutinized carefully. Antitrust compliance is everyone’s responsibility; however, please seek legal counsel if you have any questions or concerns.

Presentation Disclaimer

Agenda

- Objectives
- Introduction to Liability Cashflows
- New Dimension of Liability Cashflows
- Practical Considerations and Applications

Objectives

- By the end of this session, attendees will be able to:
  - Explain how introducing a new dimension to liability cashflows can enable better modeling of complex plan design features
  - Describe the most effective way to model different parts of a complex plan from a cashflow perspective
  - Apply the introduced techniques to practical examples to improve accuracy and quality of analysis provided to the plan sponsors

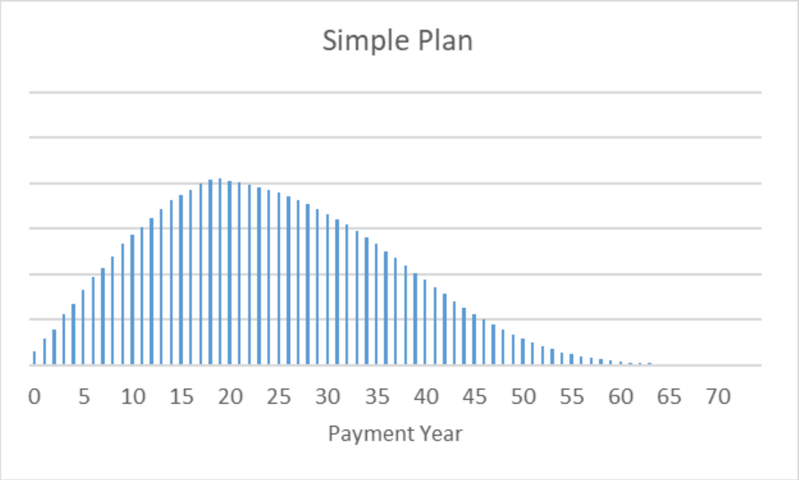
Introduction to Liability Cashflows

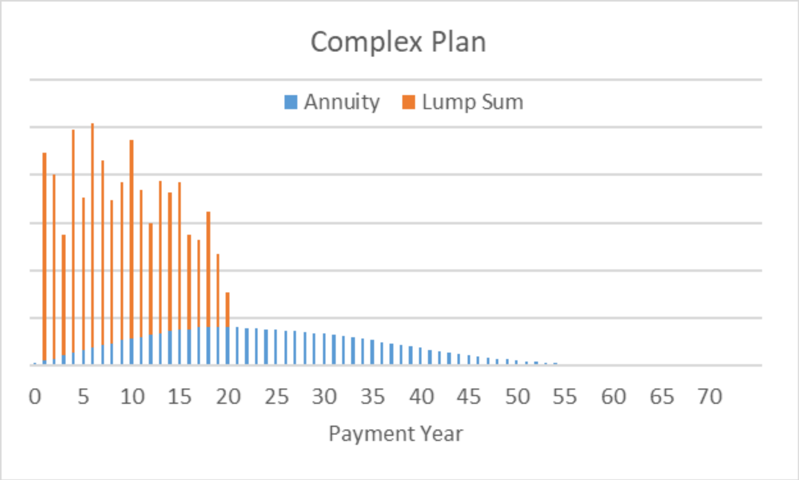
How are Projected Liability Cashflows Used?

Actuarial valuation software generates projected liability cashflows by payment year

Investment managers use projected cashflows for portfolio decisions (duration, liquidity, etc.)

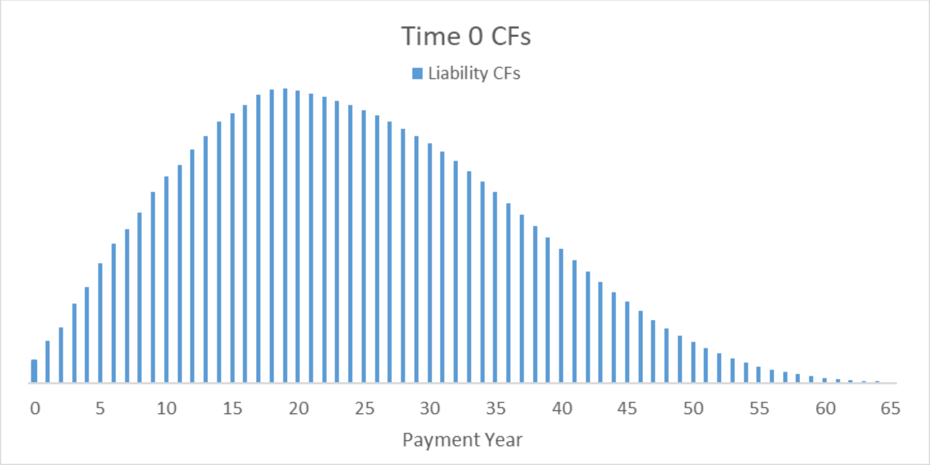
Portfolio decisions can only be effective if cashflows are a good representation of expected outflows

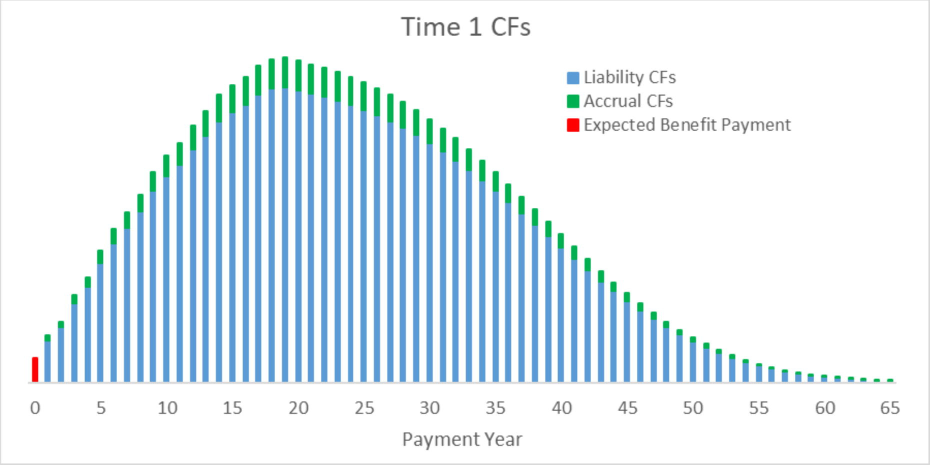




Traditional vs. Cashflow based Valuation

	Traditional Valuation	Cashflow based Valuation
AL_0	PV of accrued benefits	PV of Liability CFs after time 0
NC_0	One year's worth of service accruals	PV of accrual CFs
BP_0	First year expected liability CF	First year expected liability CF
AL_1	$[AL_0 + NC_0] \times (1+i) - BP_{exp,0-1} \times (1+i/2)$	PV of Liability CFs after time 1 incl. adjustment for accruals





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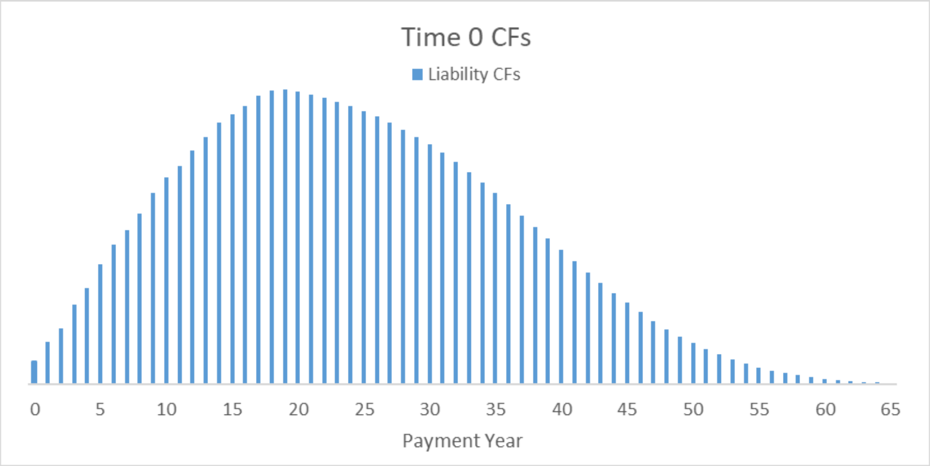
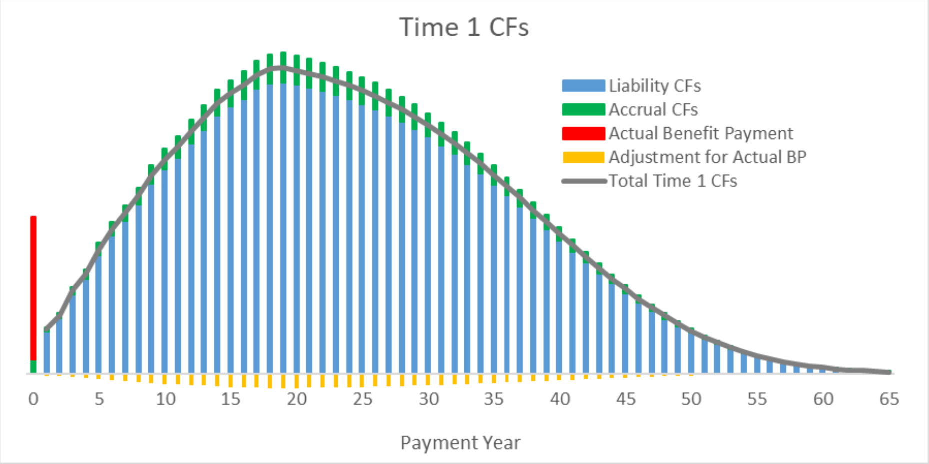
Traditional vs. Cashflow based Valuation (cont.)

	Traditional Valuation	Cashflow based Valuation
AL_0	PV of accrued benefits	PV of Liability CFs after time 0
NC_0	One year's worth of service accruals	PV of accrual CFs
BP_0	First year actual liability CF	First year actual liability CF
AL_1	$[AL_0 + NC_0] \times (1+i) – BP_{act,0-1} \times (1+i/2)$	PV of Liability CFs after time 1 incl. adjustment for accruals and actual BPs





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New Dimension of Liability Cashflows

New Dimension

- By applying actuarial techniques, cashflows by payment year can be:
  - “Rolled forward” with actual benefit payments and service costs

    → sufficient for simple plans
  - Transformed to two dimensions – payment year and commencement year – to capture pre- and post- indexation, and pre- and post- discount rates

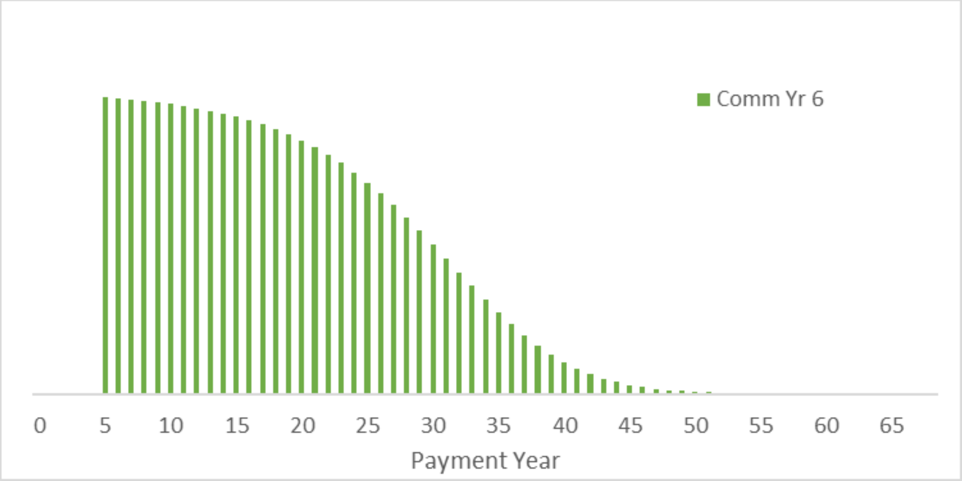
    → important for complex plans
- 2D Transformation especially useful for modelling:
  - Cash balance and pension equity plans with interest crediting rates
  - Lump sum paying plans
  - Plans paying COLAs

Cashflow Example 1

Example 1	
Member status	Active
Age	55
Plan type	Final average
Retirement decrement	100% at age 60
Other decrements	None
Pre-retirement interest crediting	None
Post-retirement indexing	None
Lump sum election	0%

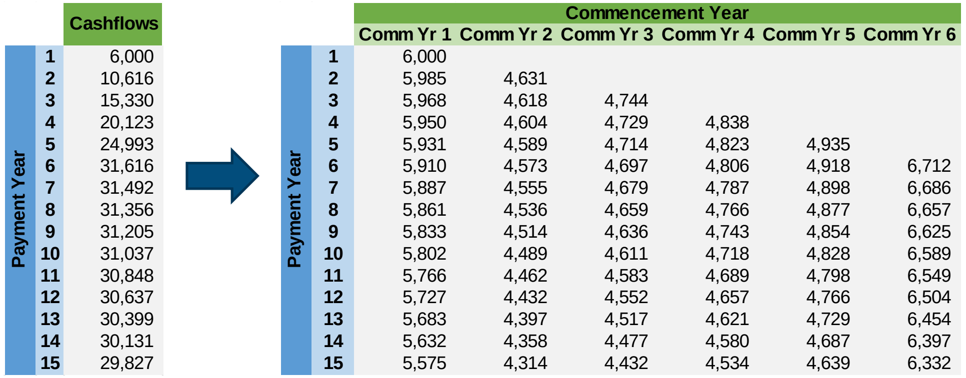
Payment Year	Cashflows
1	
2	
3	
4	
5	
6	33,560
7	33,429
8	33,284
9	33,124
10	32,945
11	32,745
12	32,521
13	32,269
14	31,983
15	31,661

	Commencement Year					
Payment Year	Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
1						
2						
3						
4						
5						
6						33,560
7						33,429
8						33,284
9						33,124
10						32,945
11						32,745
12						32,521
13						32,269
14						31,983
15						31,661



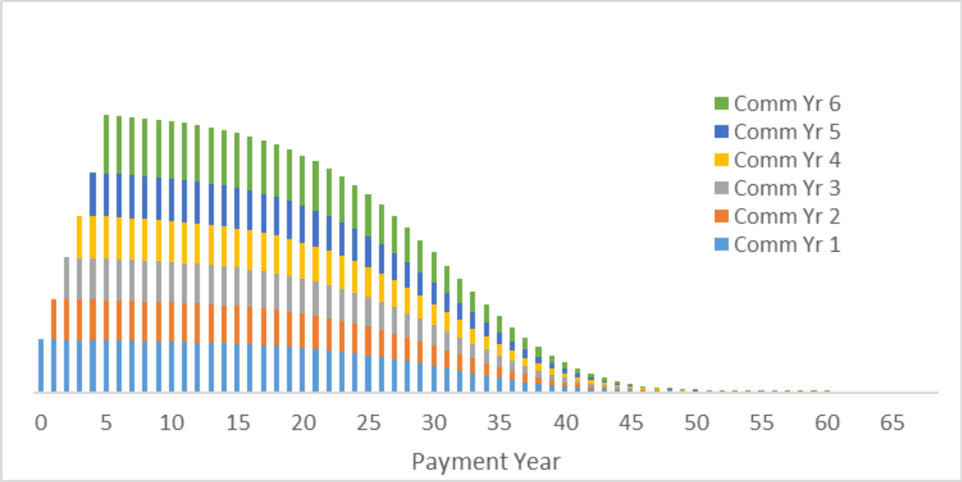
Cashflow Example 2

Example 2	
Member status	Active
Age	55
Plan type	Final average
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Pre-retirement interest crediting	None
Post-retirement indexing	None
Lump sum election	0%



Payment Year	Cashflows
1	6,000
2	10,616
3	15,330
4	20,123
5	24,993
6	31,616
7	31,492
8	31,356
9	31,205
10	31,037
11	30,848
12	30,637
13	30,399
14	30,131
15	29,827

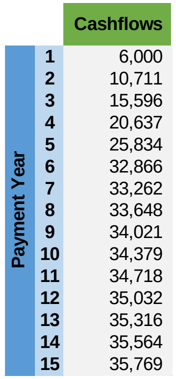
	Commencement Year					
Payment Year	Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
1	6,000					
2	5,985	4,631				
3	5,968	4,618	4,744			
4	5,950	4,604	4,729	4,838		
5	5,931	4,589	4,714	4,823	4,935	
6	5,910	4,573	4,697	4,806	4,918	6,712
7	5,887	4,555	4,679	4,787	4,898	6,686
8	5,861	4,536	4,659	4,766	4,877	6,657
9	5,833	4,514	4,636	4,743	4,854	6,625
10	5,802	4,489	4,611	4,718	4,828	6,589
11	5,766	4,462	4,583	4,689	4,798	6,549
12	5,727	4,432	4,552	4,657	4,766	6,504
13	5,683	4,397	4,517	4,621	4,729	6,454
14	5,632	4,358	4,477	4,580	4,687	6,397
15	5,575	4,314	4,432	4,534	4,639	6,332



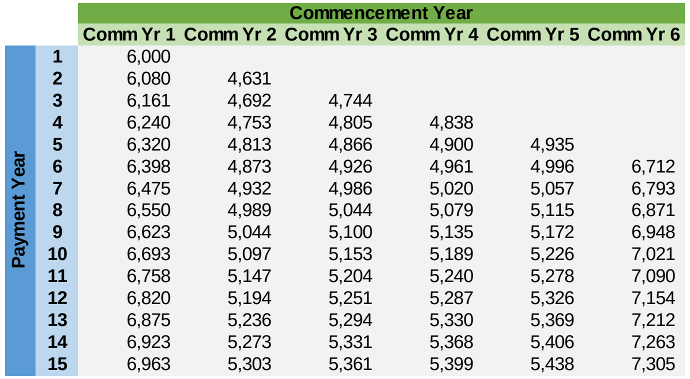
Cashflow Example 3

Example 3	
Member status	Active
Age	55
Plan type	Final average
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Pre-retirement interest crediting	None
Post-retirement indexing	80% of CPI*
Lump sum election	0%

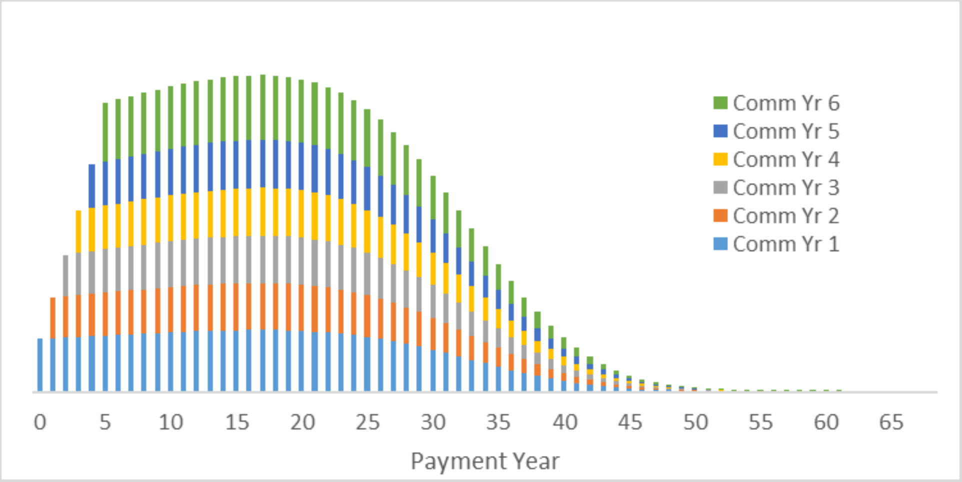
*CPI = 2%



Payment Year		Cashflows
	1	6,000
	2	10,711
	3	15,596
	4	20,637
	5	25,834
	6	32,866
	7	33,262
	8	33,648
	9	34,021
	10	34,379
	11	34,718
	12	35,032
	13	35,316
	14	35,564
	15	35,769



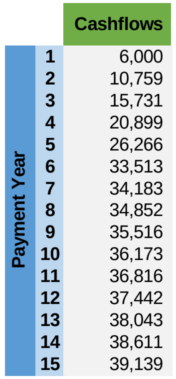
		Commencement Year					
Payment Year		Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
	1	6,000					
	2	6,080	4,631				
	3	6,161	4,692	4,744			
	4	6,240	4,753	4,805	4,838		
	5	6,320	4,813	4,866	4,900	4,935	
	6	6,398	4,873	4,926	4,961	4,996	6,712
	7	6,475	4,932	4,986	5,020	5,057	6,793
	8	6,550	4,989	5,044	5,079	5,115	6,871
	9	6,623	5,044	5,100	5,135	5,172	6,948
	10	6,693	5,097	5,153	5,189	5,226	7,021
	11	6,758	5,147	5,204	5,240	5,278	7,090
	12	6,820	5,194	5,251	5,287	5,326	7,154
	13	6,875	5,236	5,294	5,330	5,369	7,212
	14	6,923	5,273	5,331	5,368	5,406	7,263
	15	6,963	5,303	5,361	5,399	5,438	7,305



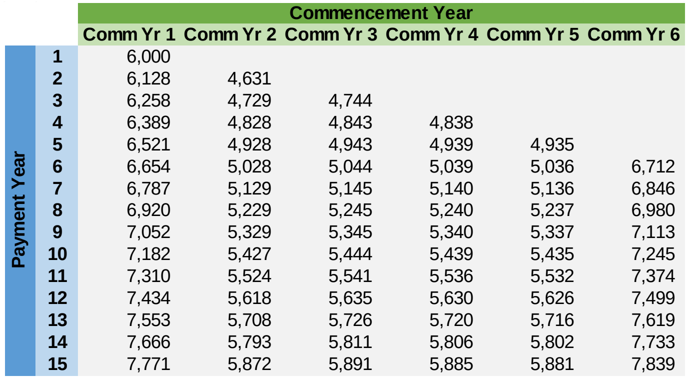
Cashflow Example 3 – Shock Indexing

Example 3	
Member status	Active
Age	55
Plan type	Final average
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Pre-retirement interest crediting	None
Post-retirement indexing	80% of CPI*
Lump sum election	0%

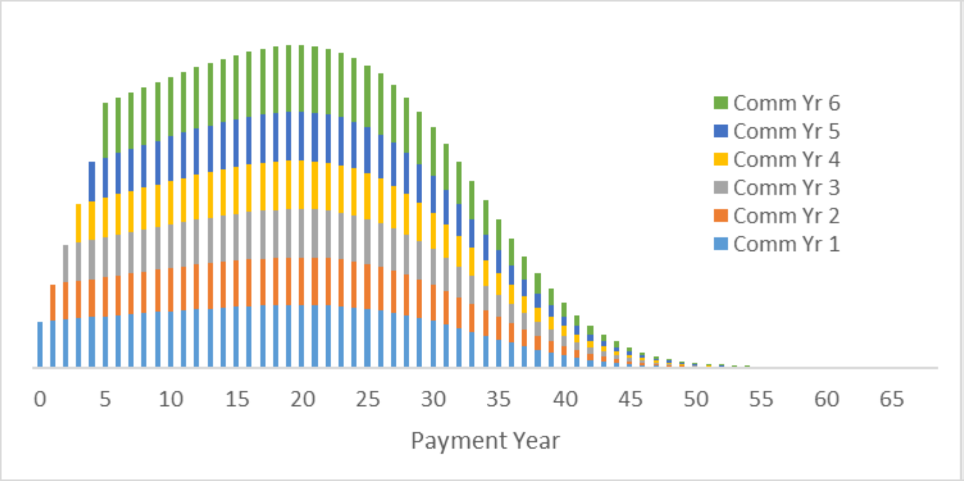
*CPI = 3%



Payment Year	Cashflows
1	6,000
2	10,759
3	15,731
4	20,899
5	26,266
6	33,513
7	34,183
8	34,852
9	35,516
10	36,173
11	36,816
12	37,442
13	38,043
14	38,611
15	39,139



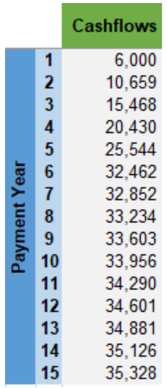
Payment Year	Commencement Year					
	Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
1	6,000					
2	6,128	4,631				
3	6,258	4,729	4,744			
4	6,389	4,828	4,843	4,838		
5	6,521	4,928	4,943	4,939	4,935	
6	6,654	5,028	5,044	5,039	5,036	6,712
7	6,787	5,129	5,145	5,140	5,136	6,846
8	6,920	5,229	5,245	5,240	5,237	6,980
9	7,052	5,329	5,345	5,340	5,337	7,113
10	7,182	5,427	5,444	5,439	5,435	7,245
11	7,310	5,524	5,541	5,536	5,532	7,374
12	7,434	5,618	5,635	5,630	5,626	7,499
13	7,553	5,708	5,726	5,720	5,716	7,619
14	7,666	5,793	5,811	5,806	5,802	7,733
15	7,771	5,872	5,891	5,885	5,881	7,839



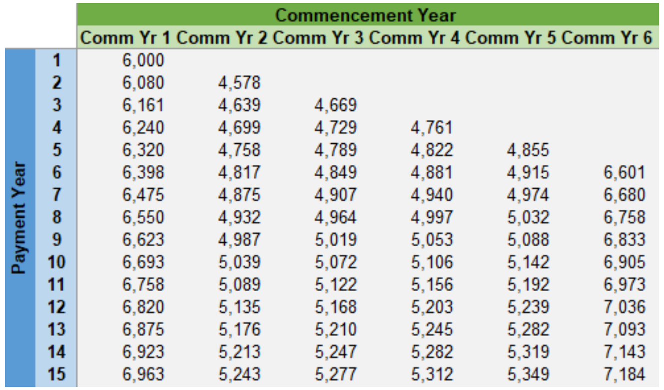
Cashflow Example 4

Example 4	
Member status	Active
Age	55
Plan type	Cash balance (paid as annuity)
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Pre-retirement interest crediting	30-year treasury yield*
Post-retirement indexing	80% of CPI**
Lump sum election	0%

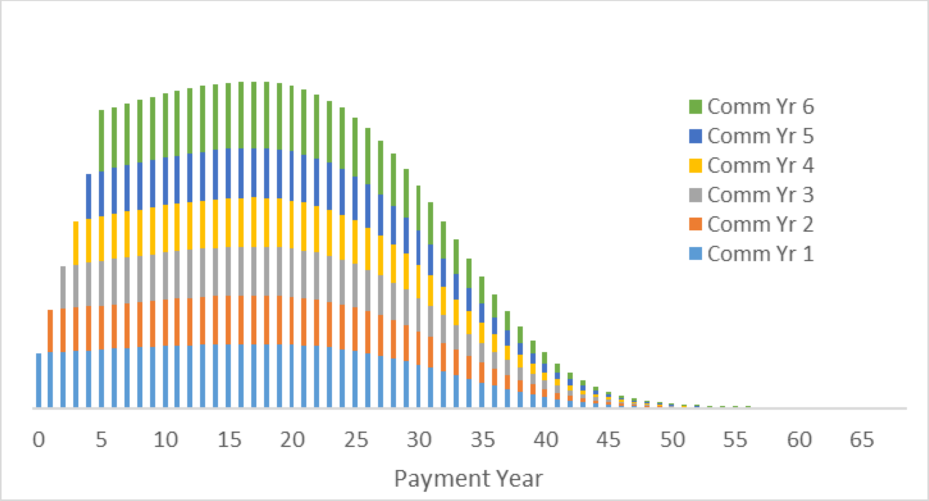
*Interest Crediting Rate (ICR) = 2%
**CPI = 2%



Payment Year		Cashflows
	1	6,000
	2	10,659
	3	15,468
	4	20,430
	5	25,544
	6	32,462
	7	32,852
	8	33,234
	9	33,603
	10	33,956
	11	34,290
	12	34,601
	13	34,881
	14	35,126
	15	35,328



		Commencement Year					
		Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
Payment Year	1	6,000					
	2	6,080	4,578				
	3	6,161	4,639	4,669			
	4	6,240	4,699	4,729	4,761		
	5	6,320	4,758	4,789	4,822	4,855	
	6	6,398	4,817	4,849	4,881	4,915	6,601
	7	6,475	4,875	4,907	4,940	4,974	6,680
	8	6,550	4,932	4,964	4,997	5,032	6,758
	9	6,623	4,987	5,019	5,053	5,088	6,833
	10	6,693	5,039	5,072	5,106	5,142	6,905
	11	6,758	5,089	5,122	5,156	5,192	6,973
	12	6,820	5,135	5,168	5,203	5,239	7,036
	13	6,875	5,176	5,210	5,245	5,282	7,093
	14	6,923	5,213	5,247	5,282	5,319	7,143
	15	6,963	5,243	5,277	5,312	5,349	7,184

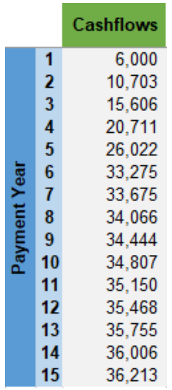


Cashflow Example 4 – Shock Interest Credit

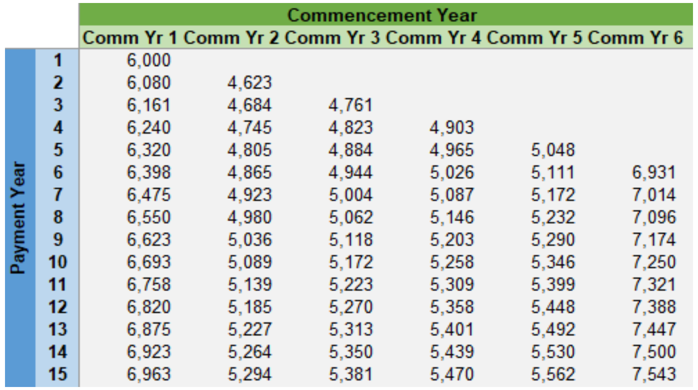
Example 4	
Member status	Active
Age	55
Plan type	Cash balance (paid as annuity)
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Pre-retirement interest crediting	30-year treasury yield*
Post-retirement indexing	80% of CPI**
Lump sum election	0%

*Interest Crediting Rate (ICR) = 3%

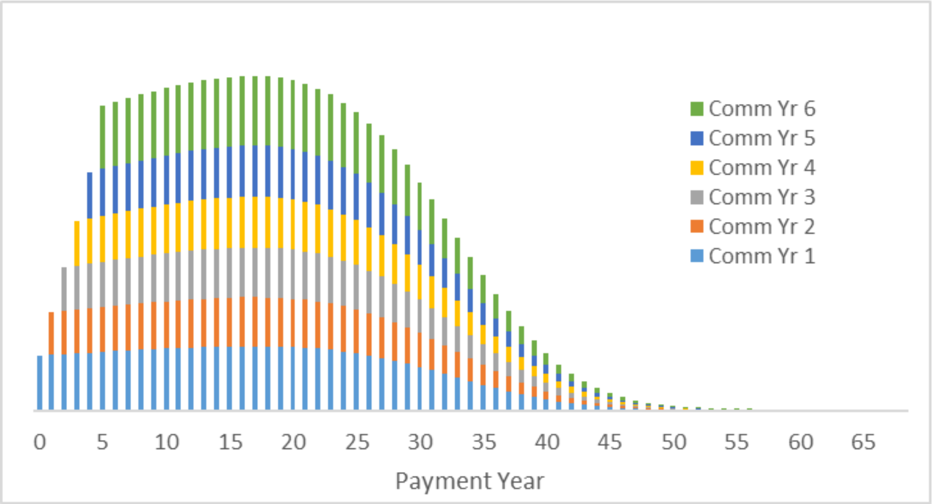
**CPI = 2%



Payment Year		Cashflows
	1	6,000
	2	10,703
	3	15,606
	4	20,711
	5	26,022
	6	33,275
	7	33,675
	8	34,066
	9	34,444
	10	34,807
	11	35,150
	12	35,468
	13	35,755
	14	36,006
	15	36,213



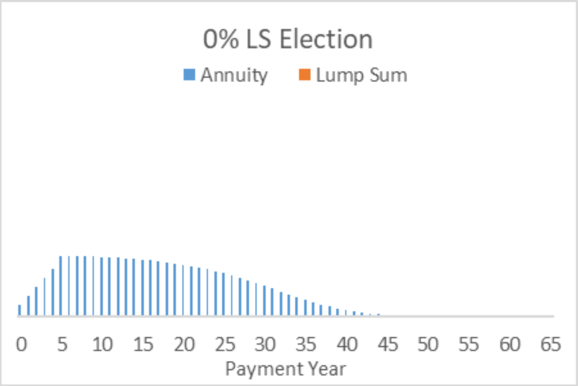
Payment Year		Commencement Year					
		Comm Yr 1	Comm Yr 2	Comm Yr 3	Comm Yr 4	Comm Yr 5	Comm Yr 6
	1	6,000					
	2	6,080	4,623				
	3	6,161	4,684	4,761			
	4	6,240	4,745	4,823	4,903		
	5	6,320	4,805	4,884	4,965	5,048	
	6	6,398	4,865	4,944	5,026	5,111	6,931
	7	6,475	4,923	5,004	5,087	5,172	7,014
	8	6,550	4,980	5,062	5,146	5,232	7,096
	9	6,623	5,036	5,118	5,203	5,290	7,174
	10	6,693	5,089	5,172	5,258	5,346	7,250
	11	6,758	5,139	5,223	5,309	5,399	7,321
	12	6,820	5,185	5,270	5,358	5,448	7,388
	13	6,875	5,227	5,313	5,401	5,492	7,447
	14	6,923	5,264	5,350	5,439	5,530	7,500
	15	6,963	5,294	5,381	5,470	5,562	7,543

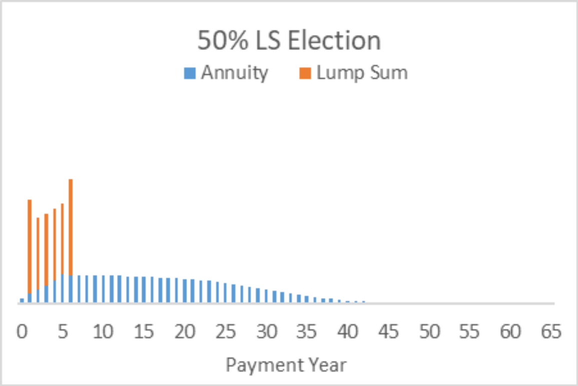


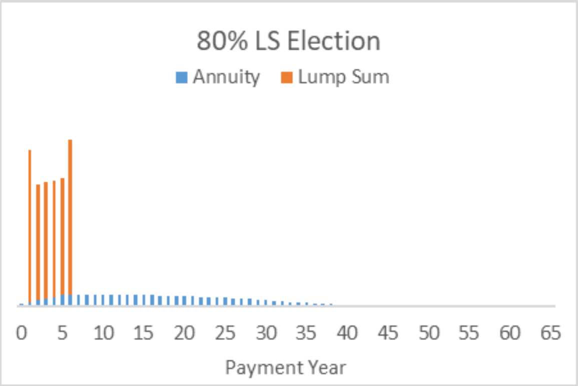
Cashflow Example 2 – With Lump Sum Election Option

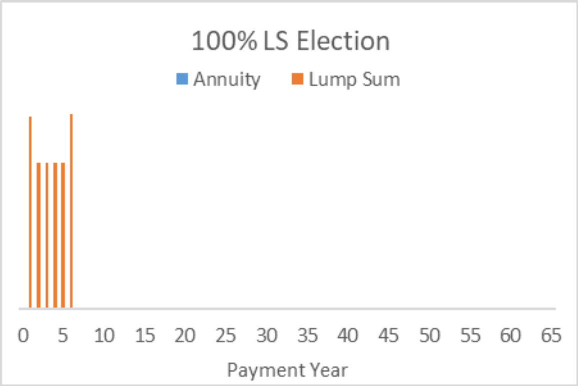
Example 2	
Member status	Active
Age	55
Plan type	Final average
Retirement decrement	20% at age 55, 15% at ages 56-59, 100% at 60
Other decrements	None
Post retirement indexing	None
Lump sum election	0%/50%/80%/100%

Lump sum discount rate can be a flat rate or yield curve based









Practical Considerations and Applications

Practical Considerations

Common Issues	Solution
Cashflows outdated	Rollforward cashflows with actual benefit payments and service costs Chopping off first year cashflow is dangerous!
Service cost cashflows not available	Prorate active past service cashflows using (SC/Active Liability) ratio
2D cashflows not available	Apply 1D to 2D annuity cashflow transformation
Complex plan (COLA, crediting rates)	Adjust 2D cashflows to reflect desired indexation and crediting rates
Interest rate sensitive lump sums	Use 1D annuity substitution cashflows to capture correct duration But use "collapsed" 2D cashflows for ALM projections
Plan has multiple benefit structures	Request more granular CFs – split by participant type, plan design type and form of payment; request sensitivity cashflows, if applicable

1D to 2D Annuity Cashflow Transformation

Payment year

1	CF_1
2	CF_2
3	CF_3
4	CF_4
…	…

Commencement year

Payment year

	1	2	3	…
1	$CF_{1,1}$	0	0	…
2	$CF_{1,1} \times I_1 \times p_1$	$CF_{2,2} = CF_2 - CF_{1,2}$	0	…
3	$CF_{1,2} \times I_2 \times p_2$	$CF_{2,2} \times I_2 \times p_2$	$CF_{3,3} = CF_3 - CF_{1,3} - CF_{2,3}$	…
4	$CF_{1,3} \times I_3 \times p_3$	$CF_{2,3} \times I_3 \times p_3$	$CF_{3,3} \times I_3 \times p_3$	…
…	…	…	…	…

CF_y = Expected cashflow paid in year *y*

$CF_{x,y}$ = Expected cashflow commencing in year *x* and paid in year *y*

p_x = assumed one year survival probability of cashflows paid in year *x*

I_y = inflationary increase factor in year y

Helps capture LS paying plans, CB plans paying annuities (with fixed conversion rates) and plans paying COLAs

Collapsing 2D Annuity Cashflows to Lump Sums

Commencement year

Payment year

	1	2	3	…
1	$CF_{1,1}$	0	0	0
2	$CF_{1,2}$	$CF_{2,2}$	0	0
3	$CF_{1,3}$	$CF_{2,3}$	$CF_{3,3}$	0
4	$CF_{1,4}$	$CF_{2,4}$	$CF_{3,4}$	$CF_{4,4}$
…	…	…	…	…

→

Commencement year

Payment year

	1	2	3	…
1	$(1-LS)\times CF_{1,1}$ $+LS\times LSCF_{1,1}$	0	0	…
2	$(1-LS)\times CF_{1,2}$	$(1-LS)\times CF_{2,2}$ $+LS\times LSCF_{2,2}$	0	…
3	$(1-LS)\times CF_{1,3}$	$(1-LS)\times CF_{2,3}$	$(1-LS)\times CF_{3,3}$ $+LS\times LSCF_{3,3}$	…
4	$(1-LS)\times CF_{1,4}$	$(1-LS)\times CF_{2,4}$	$(1-LS)\times CF_{3,4}$	…
…	…	…	…	…

$CF_{x,y}$ = Expected cashflow commencing in year *x* and paid in year *y*

LS = assumed percentage of benefits taken as a lump sum

$LSCF_{i,j}$ = Lump sum cashflow, where $LSCF_{i,i} = \sum CF_{i,j}DF_{i,j}$

$DF_{i,j}$ = Discount factor for cashflow paid in year *j* back to year *i*

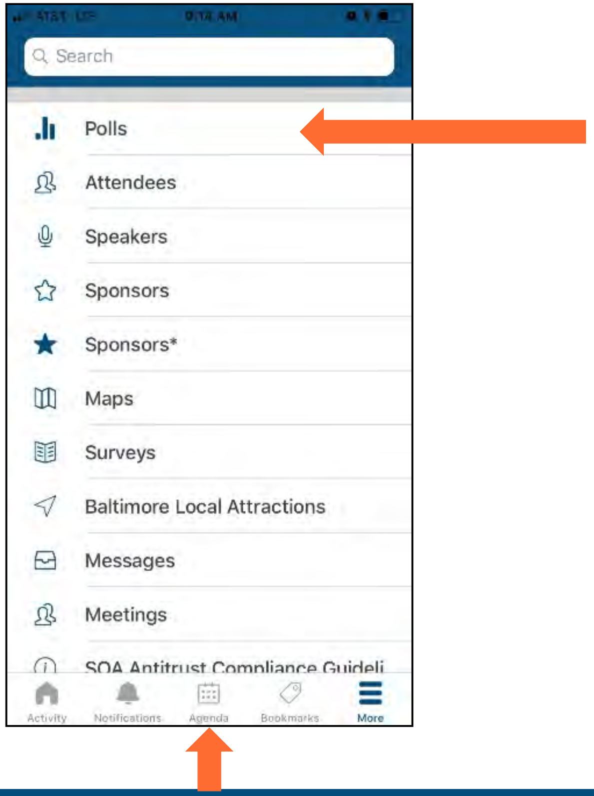
Helps capture interest sensitive lump sum payments.

Practical Application: Case study

- MK Industries Super Complex Pension Plan
  - Cash balance component (A+B approach)
  - Traditional final salary benefits (some payable as lump sums)
  - Post-retirement COLAs
- 1D cashflows provided for modelling
  - Split by participant type
  - Split by plan design feature (i.e. COLA/non-COLA, CB/Traditional benefit)
  - Split by form of payment (Annuity/LS), where applicable
  - Annuity substitution cashflows provided for traditional lump sum eligible benefits
- Cash balance benefits converted to annuities using fixed conversion rate
- 100% of actives assumed to take traditional benefit as a lump sum

To Participate, look for Polls in the SOA Event App or visit annual.cnf.io in your browser

Find The Polls Feature Under **More** In The Event App or Under This Session in the Agenda



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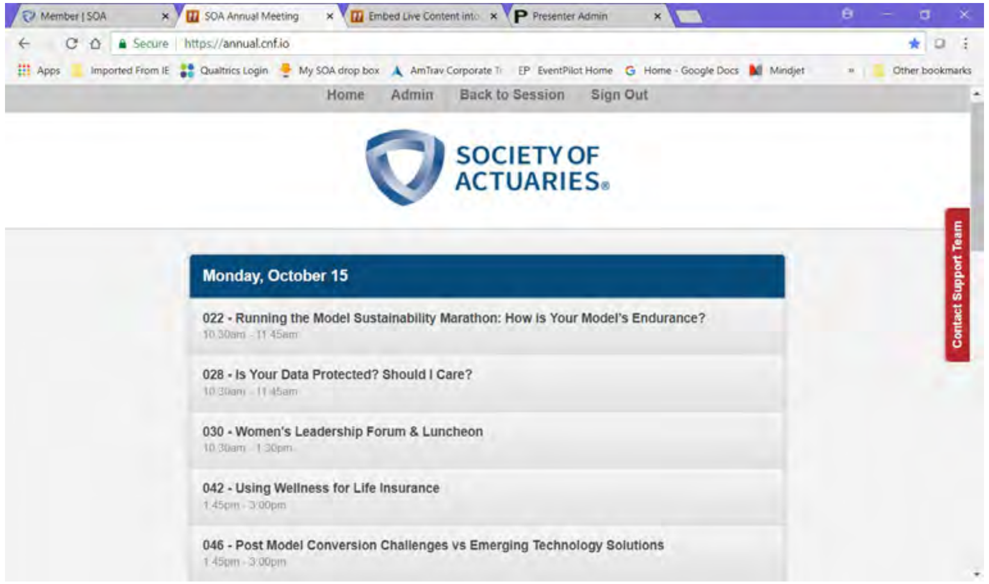

Monday, October 15

022 - Running the Model Sustainability Marathon: How is Your Model's Endurance?
10:30am - 11:45am

028 - Is Your Data Protected? Should I Care?
10:30am - 11:45am

030 - Women's Leadership Forum & Luncheon
10:30am - 1:30pm

042 - Using Wellness for Life Insurance
1:45pm - 3:00pm

046 - Post Model Conversion Challenges vs Emerging Technology Solutions
1:45pm - 3:00pm

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: We are looking to generate ALM projections as of 12/31/2019, but the 1D cashflow profile provided is as of 12/31/2018. Which of the following adjustments are appropriate?

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: We are looking to project cashflows under various CPI scenarios to recommend an appropriate inflation hedge. The cashflows provided have 2% post-retirement CPI embedded in them. What’s the best way to adjust active cashflows for this purpose?

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: We are looking to project cashflows for the cash balance component of the plan under various ICR assumptions. The annuity cashflows provided have 2% pre-retirement ICR embedded in them. What's the best way to adjust the cashflows for this purpose?

Live Content Slide

When playing as a slideshow, this slide will display live content

Poll: We are looking to perform ALM projections for the lump sum component of the plan. Both annuity substitution and lump sum cashflows were provided for traditional lump sum eligible benefits. What's the best way to adjust the CFs for this purpose?

Modelling extensions

- “Greater of” plan provisions
  - Participant receives max (PV of frozen annuity, Cash balance account)
  - Derive “Real/Nominal” cashflow split to capture ICR exposure
  - Granular cashflow splits can minimize the modelling simplification impact

- Mortality assumptions
  - Analyze impact of changes to base/improvement tables
  - Utilizes 2D cashflow grids – no individual participant data needed
  - “Ratio of Lx” approach

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