Article from
**The Financial Reporter**
September 2019
Issue 119

# Discounting Stochastic Scenarios Under IFRS 17's OCI Election Provision

By Darin Zimmerman

*Author's note: The pronoun "we" appears throughout this article because I owe a debt of gratitude to many of my colleagues who contributed to the article but chose not to attach their names for publication.*

It is widely understood that path-dependent discounting is critical in calculating the correct price of options and guarantees when using stochastic scenarios to perform a valuation. International Financial Reporting Standard 17 (IFRS 17) requires the use of two sets of discount rates for a single set of cash flows when one elects a systematic disaggregation of income through other comprehensive income (OCI). IFRS 17 describes three potential discount rates: (1) the current rates; (2) the locked-in rates at time of initial recognition to measure the change in nonfinancial assumptions for contractual service margin (CSM); and (3) the adjusted locked-in rates from IFRS 17 paragraph B132(a), using either the effective yield method or the projected crediting rate method for products with indirect participation features.

The standard is not explicit about how someone is supposed to discount one set of cash flows using different rates when one of those is potentially hundreds of scenarios of stochastically generated rates. We are proposing one method we believe provides reasonable results while capturing the spirit of what the standard is trying to achieve. This method applies an adjustment to the individual scenario cash flows in order to calibrate them back to the original discount rates. The average of the cash flows will then be a single scenario of cash flows that reproduces the correct price for options and guarantees. We believe this single set of cash flows will then be suitable for application to the other discount rates.

## ILLUSTRATION OF THE PROBLEM

To reiterate, path-dependent discounting is critical in deriving the appropriate value of options and guarantees. Consider the following numerical example with a hypothetical product. It is a fixed deferred annuity where the crediting strategy declares a rate equal to the 1-year risk-free rate. It has a product guarantee of 1.5 percent annual growth in all years. (This results in a minimum surrender value at year 10 of $116.05 for a $100 premium.) At the time of initial recognition, the risk-free rate is 4.5 percent in all years, and the illiquidity premium appropriate for the product is 20 basis points in all years. To price the value of the guarantee correctly, we use the 10 scenarios shown in

Figure 1
Illustrative Risk-Free Rate Scenarios

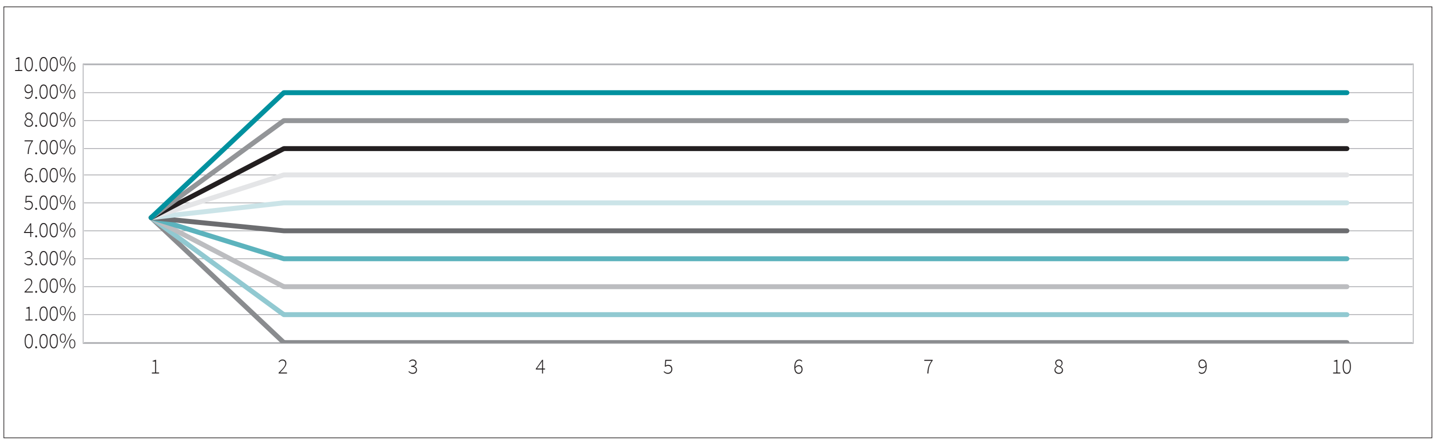

Figure 1 (not technically "stochastic" as they were designed for illustrative purposes).

The graph of path-dependent discount rates would be 20 basis points higher to reflect the appropriate illiquidity premium. The surrender assumption for this first example is zero in the first nine years and 100 percent in the 10th year. (Technically, if there is not at least a "risk" of the annuitization feature being utilized, the product likely would not qualify as insurance under IFRS 17. This example ignores the potential profit or loss of the annuitization feature for simplicity. This could be interpreted as meaning the actuary believes the annuitization feature "lacks commercial substance," which would mean the product does not qualify as insurance. Expenses are also ignored for simplicity.)

We will illustrate the importance of path-dependent discounting by showing two methods of discounting that provide an incorrect value of the liability. The first method we might use to value the product (Method 1 shown in Figure 2) simply employs a single best estimate scenario. We accumulate the account value for 10 years, compare it to the guarantee and then discount it back for 10 years.

Method 1, by using a single deterministic scenario, effectively ignores the value of options and guarantees and is not an appropriate valuation technique for products that have options and guarantees.

Next, we examine what happens when a stochastic valuation does not use path-dependent discounting. Figure 3 uses the interest rate scenarios presented in Figure 2 for fund growth but discounts the results at the average of the scenarios.

We see that Method 2 overstates the value of options and guarantees, because by discounting using only the current discount rates, it does not discount at the path-specific rates, which gives the wrong price. This is the crux of the problem when it comes to applying a different set of discount rates that is required to

Figure 2
Discounting Using a Single Best Estimate Scenario

| Method 1 (Which is Wrong) | |
|---|---|
| 4.5% accumulated for 10 years | $155.30 |
| Minimum surrender value | $116.05 |
| 4.7% discount for 10 years | 1.5829 |
| Value | $98.11 |

Figure 3
Discounting Using the Average of the Scenarios

| Method 2 (Also Wrong) | | | | | |
|---|---|---|---|---|---|
| Scenario | Cash Flow Years 1-9 | Year 10 Accum'ed Value | Year 10 Surrender Value | Discount Rate | PV Current Rates |
| 1 | $- | $104.50 | $116.05 | 1.5829 | $73.32 |
| 2 | $- | $114.29 | $116.05 | 1.5829 | $73.32 |
| 3 | $- | $124.89 | $124.89 | 1.5829 | $78.90 |
| 4 | $- | $136.35 | $136.35 | 1.5829 | $86.14 |
| 5 | $- | $148.74 | $148.74 | 1.5829 | $93.96 |
| 6 | $- | $162.11 | $162.11 | 1.5829 | $102.41 |
| 7 | $- | $176.55 | $176.55 | 1.5829 | $111.53 |
| 8 | $- | $192.12 | $192.12 | 1.5829 | $121.37 |
| 9 | $- | $208.90 | $208.90 | 1.5829 | $131.97 |
| 10 | $- | $226.96 | $226.96 | 1.5829 | $143.38 |
| Average | | | | | $101.63 |

Figure 4
Discounting Using Path-Dependent Rates

| Method 3 (Correct) | | | | | |
|---|---|---|---|---|---|
| Scenario | Cash Flow Years 1-9 | Year 10 Accum'ed Value | Year 10 Surrender Value | Path-Specific Discount | PV Path-Specific Rates |
| 1 | $- | $104.50 | $116.05 | 1.0660 | $108.87 |
| 2 | $- | $114.29 | $116.05 | 1.1657 | $99.56 |
| 3 | $- | $124.89 | $124.89 | 1.2735 | $98.06 |
| 4 | $- | $136.35 | $136.35 | 1.3902 | $98.08 |
| 5 | $- | $148.74 | $148.74 | 1.5162 | $98.10 |
| 6 | $- | $162.11 | $162.11 | 1.6523 | $98.11 |
| 7 | $- | $176.55 | $176.55 | 1.7991 | $98.13 |
| 8 | $- | $192.12 | $192.12 | 1.9575 | $98.15 |
| 9 | $- | $208.90 | $208.90 | 2.1281 | $98.16 |
| 10 | $- | $226.96 | $226.96 | 2.3118 | $98.18 |
| Average | | | | | $99.34 |

disaggregate insurance finance income or expense. If we applied the single set of locked-in discount rates to the 10 scenarios of stochastic cash flows generated using current rates, the value of options and guarantees would be misstated.

Finally, we perform the valuation correctly using the path-dependent discount rates, as shown in Figure 4.

In this example, the expected profit from the product is only 66 cents. If the risk adjustment is more than 66 cents, we will have an onerous contract with a starting loss component. We also see an elevated cost associated with the two scenarios where the rates are below the guarantee, as well as a very similar cost for all scenarios where the guarantee does not impact policy cash flows.

## SOLVING THE PROBLEM

The following technique attempts to recalibrate each scenario's cash flows to the current rates so that we can calculate an average cash flow across all scenarios and then revalue the average adjusted cash flows using the locked-in rates. When this is done, the result will be internally consistent and will properly value options and guarantees. This numerical example differs from the preceding one in only one way: We have altered the surrender assumption to be 5 percent in years 1 through 9 and 100 percent in year 10 to make it slightly more realistic. We will also refer to the current discount rates as Scenario 0. (Note: The model does not process Scenario 0! That is, the model does not generate cash flows for Scenario 0. Instead, Scenario 0 cash flows will be the average of the cash flows in scenarios 1 through 10.) The transform that is applied to produce adjusted cash flows is to multiply each cash flow by a factor that is a ratio of the accumulation factors for Scenario 0 and the scenario being processed:

$$CF_{ij}^{adj} = CF_{ij} \times \prod_{k=1}^{j} (1 + r_{0k}) \div \prod_{k=1}^{j} (1 + r_{ik}),$$

where $i$ is the scenario, $j$ is a time period, and $r_{0k}$ is the current discount rate (Scenario 0) for time step $k$. More simply, the adjusted cash flow for Scenario $i$ at time step $j$ is the actual cash flow for Scenario $i$ at time step $j$ multiplied by the accumulation factor for time step $j$ using Scenario 0 divided by Scenario $i$'s path-dependent accumulation factor for time step $j$.

Using the new surrender assumption, we get the account values, policy cash flows, discount rates and accumulation factors shown in Figure 5.

In this formula, the rates come from the discount rates table, where Scenario $i$ is a row and time step $j$ is a column. The products in the formula result in the accumulation factors. So the adjusted cash flow for Scenario 7, time step 2, would take the original cash flow for Scenario 7 at time step 2; multiply it by the accumulation factor for Scenario 7, time step 2; and then divide by the accumulation factor for Scenario 0, time step 2. That is: $5.26 × 89.94% ÷ 91.22% = $5.19. Figure 6 contains all of the adjusted cash flows in rows 1 through 10 and the simple average of them in Scenario 0.

Figure 5
Account Values, Cash Flows, Discount Rates and Accumulation Factors

| AV (B4 Surr) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $104.50 | $100.76 | $97.16 | $93.69 | $90.34 | $87.11 | $84.00 | $80.99 | $78.10 | $75.30 |
| 2 | $104.50 | $100.76 | $97.16 | $93.69 | $90.34 | $87.11 | $84.00 | $80.99 | $78.10 | $75.30 |
| 3 | $104.50 | $101.26 | $98.12 | $95.08 | $92.13 | $89.28 | $86.51 | $83.83 | $81.23 | $78.71 |
| 4 | $104.50 | $102.25 | $100.05 | $97.90 | $95.80 | $93.74 | $91.72 | $89.75 | $87.82 | $85.93 |
| 5 | $104.50 | $103.25 | $102.01 | $100.78 | $99.57 | $98.38 | $97.20 | $96.03 | $94.88 | $93.74 |
| 6 | $104.50 | $104.24 | $103.98 | $103.72 | $103.46 | $103.20 | $102.94 | $102.68 | $102.43 | $102.17 |
| 7 | $104.50 | $105.23 | $105.97 | $106.71 | $107.46 | $108.21 | $108.97 | $109.73 | $110.50 | $111.27 |
| 8 | $104.50 | $106.22 | $107.98 | $109.76 | $111.57 | $113.41 | $115.28 | $117.18 | $119.12 | $121.08 |
| 9 | $104.50 | $107.22 | $110.00 | $112.86 | $115.80 | $118.81 | $121.90 | $125.07 | $128.32 | $131.66 |
| 10 | $104.50 | $108.21 | $112.05 | $116.03 | $120.15 | $124.41 | $128.83 | $133.40 | $138.14 | $143.04 |

| Cash Flow | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $5.23 | $5.04 | $4.86 | $4.68 | $4.52 | $4.36 | $4.20 | $4.05 | $3.90 | $75.30 |
| 2 | $5.23 | $5.04 | $4.86 | $4.68 | $4.52 | $4.36 | $4.20 | $4.05 | $3.90 | $75.30 |
| 3 | $5.23 | $5.06 | $4.91 | $4.75 | $4.61 | $4.46 | $4.33 | $4.19 | $4.06 | $78.71 |
| 4 | $5.23 | $5.11 | $5.00 | $4.90 | $4.79 | $4.69 | $4.59 | $4.49 | $4.39 | $85.93 |
| 5 | $5.23 | $5.16 | $5.10 | $5.04 | $4.98 | $4.92 | $4.86 | $4.80 | $4.74 | $93.74 |
| 6 | $5.23 | $5.21 | $5.20 | $5.19 | $5.17 | $5.16 | $5.15 | $5.13 | $5.12 | $102.17 |
| 7 | $5.23 | $5.26 | $5.30 | $5.34 | $5.37 | $5.41 | $5.45 | $5.49 | $5.52 | $111.27 |
| 8 | $5.23 | $5.31 | $5.40 | $5.49 | $5.58 | $5.67 | $5.76 | $5.86 | $5.96 | $121.08 |
| 9 | $5.23 | $5.36 | $5.50 | $5.64 | $5.79 | $5.94 | $6.09 | $6.25 | $6.42 | $131.66 |
| 10 | $5.23 | $5.41 | $5.60 | $5.80 | $6.01 | $6.22 | $6.44 | $6.67 | $6.91 | $143.04 |

Continued on page 32

Figure 5, Cont.
Account Values, Cash Flows, Discount Rates and Accumulation Factors

| Discount Rates | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% | 4.70% |
| 1 | 4.70% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% | 0.20% |
| 2 | 4.70% | 1.20% | 1.20% | 1.20% | 1.20% | 1.20% | 1.20% | 1.20% | 1.20% | 1.20% |
| 3 | 4.70% | 2.20% | 2.20% | 2.20% | 2.20% | 2.20% | 2.20% | 2.20% | 2.20% | 2.20% |
| 4 | 4.70% | 3.20% | 3.20% | 3.20% | 3.20% | 3.20% | 3.20% | 3.20% | 3.20% | 3.20% |
| 5 | 4.70% | 4.20% | 4.20% | 4.20% | 4.20% | 4.20% | 4.20% | 4.20% | 4.20% | 4.20% |
| 6 | 4.70% | 5.20% | 5.20% | 5.20% | 5.20% | 5.20% | 5.20% | 5.20% | 5.20% | 5.20% |
| 7 | 4.70% | 6.20% | 6.20% | 6.20% | 6.20% | 6.20% | 6.20% | 6.20% | 6.20% | 6.20% |
| 8 | 4.70% | 7.20% | 7.20% | 7.20% | 7.20% | 7.20% | 7.20% | 7.20% | 7.20% | 7.20% |
| 9 | 4.70% | 8.20% | 8.20% | 8.20% | 8.20% | 8.20% | 8.20% | 8.20% | 8.20% | 8.20% |
| 10 | 4.70% | 9.20% | 9.20% | 9.20% | 9.20% | 9.20% | 9.20% | 9.20% | 9.20% | 9.20% |

| Accum Factors | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 100.00% | 95.51% | 91.22% | 87.13% | 83.22% | 79.48% | 75.91% | 72.51% | 69.25% | 66.14% | 63.17% |
| 1 | 100.00% | 95.51% | 95.32% | 95.13% | 94.94% | 94.75% | 94.56% | 94.37% | 94.18% | 94.00% | 93.81% |
| 2 | 100.00% | 95.51% | 94.38% | 93.26% | 92.15% | 91.06% | 89.98% | 88.91% | 87.86% | 86.82% | 85.79% |
| 3 | 100.00% | 95.51% | 93.45% | 91.44% | 89.47% | 87.55% | 85.66% | 83.82% | 82.02% | 80.25% | 78.52% |
| 4 | 100.00% | 95.51% | 92.55% | 89.68% | 86.90% | 84.20% | 81.59% | 79.06% | 76.61% | 74.24% | 71.93% |
| 5 | 100.00% | 95.51% | 91.66% | 87.97% | 84.42% | 81.02% | 77.75% | 74.62% | 71.61% | 68.72% | 65.95% |
| 6 | 100.00% | 95.51% | 90.79% | 86.30% | 82.04% | 77.98% | 74.13% | 70.46% | 66.98% | 63.67% | 60.52% |
| 7 | 100.00% | 95.51% | 89.94% | 84.68% | 79.74% | 75.09% | 70.70% | 66.57% | 62.69% | 59.03% | 55.58% |
| 8 | 100.00% | 95.51% | 89.10% | 83.11% | 77.53% | 72.32% | 67.47% | 62.93% | 58.71% | 54.76% | 51.09% |
| 9 | 100.00% | 95.51% | 88.27% | 81.58% | 75.40% | 69.69% | 64.40% | 59.52% | 55.01% | 50.84% | 46.99% |
| 10 | 100.00% | 95.51% | 87.46% | 80.10% | 73.35% | 67.17% | 61.51% | 56.33% | 51.58% | 47.24% | 43.26% |

Figure 6
Adjusted Cash Flows

| Adj CF | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Avg/Scn 0 | $5.23 | $5.20 | $5.17 | $5.14 | $5.12 | $5.09 | $5.06 | $5.04 | $5.01 | $99.72 |
| 1 | $5.23 | $5.26 | $5.30 | $5.34 | $5.38 | $5.43 | $5.47 | $5.51 | $5.55 | $111.82 |
| 2 | $5.23 | $5.21 | $5.20 | $5.19 | $5.17 | $5.16 | $5.15 | $5.14 | $5.13 | $102.26 |
| 3 | $5.23 | $5.19 | $5.15 | $5.11 | $5.07 | $5.04 | $5.00 | $4.96 | $4.93 | $97.83 |
| 4 | $5.23 | $5.19 | $5.15 | $5.11 | $5.07 | $5.04 | $5.00 | $4.96 | $4.93 | $97.85 |
| 5 | $5.23 | $5.19 | $5.15 | $5.11 | $5.07 | $5.04 | $5.00 | $4.97 | $4.93 | $97.87 |
| 6 | $5.23 | $5.19 | $5.15 | $5.11 | $5.08 | $5.04 | $5.00 | $4.97 | $4.93 | $97.88 |
| 7 | $5.23 | $5.19 | $5.15 | $5.11 | $5.08 | $5.04 | $5.00 | $4.97 | $4.93 | $97.90 |
| 8 | $5.23 | $5.19 | $5.15 | $5.11 | $5.08 | $5.04 | $5.00 | $4.97 | $4.93 | $97.92 |
| 9 | $5.23 | $5.19 | $5.15 | $5.11 | $5.08 | $5.04 | $5.00 | $4.97 | $4.93 | $97.93 |
| 10 | $5.23 | $5.19 | $5.15 | $5.11 | $5.08 | $5.04 | $5.00 | $4.97 | $4.93 | $97.95 |

Figure 7
Traditional Market-Consistent Valuation

| Sum Product of Figure 5 Cash Flows and Accumulation Factors | |
|---|---|
| 1 | $109.35 |
| 2 | $101.91 |
| 3 | $98.45 |
| 4 | $98.46 |
| 5 | $98.47 |
| 6 | $98.49 |
| 7 | $98.50 |
| 8 | $98.51 |
| 9 | $98.52 |
| 10 | $98.53 |
| Average | $99.92 |

Figure 8
Adjusted Cash Flows

| Valuation with Adj CFs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Avg Adj CF | $5.23 | $5.20 | $5.17 | $5.14 | $5.12 | $5.09 | $5.06 | $5.04 | $5.01 | $99.72 |
| Cur Accm Fx | 95.51% | 91.22% | 87.13% | 83.22% | 79.48% | 75.91% | 72.51% | 69.25% | 66.14% | 63.17% |
| PV of CV | $4.99 | $4.74 | $4.50 | $4.28 | $4.07 | $3.86 | $3.67 | $3.49 | $3.31 | $63.00 |
| Sum of PV | $99.92 | | | | | | | | | |

We now have two ways in which to calculate the market-consistent price of the liability. The traditional method is to use the (unadjusted) cash flows and path-dependent accumulation factors from Figure 5. This results in a market-consistent liability price of $99.92, as shown in Figure 7.

Alternatively, we can simply discount the average of the adjusted cash flows using the current discount rates to obtain a market-consistent liability price of $99.92, as shown in Figure 8.

This demonstrates that the adjusted cash flows, when discounted at the original discount rates, reproduce the price we get when we discount the unadjusted cash flows using the path-dependent discount rates. This makes the adjusted cash flows suitable for discounting at single curves, including the locked-in rates used to disaggregate insurance finance income or expense. This also potentially reduces the amount of data that must be stored during the valuation process, leading to a more cost-efficient solution for companies. ■

Darin Zimmerman, FSA, MAAA, is Sr. VP of Valuation at Athene. He can be contacted at *dzimmerman@athene.com*.