Fixed Income Attribution

A look at **Yield Curve Decomposition** and **Exposure Decomposition** approaches

112th Meeting of
The Performance Measurement Forum
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robust TECHNOLOGIES

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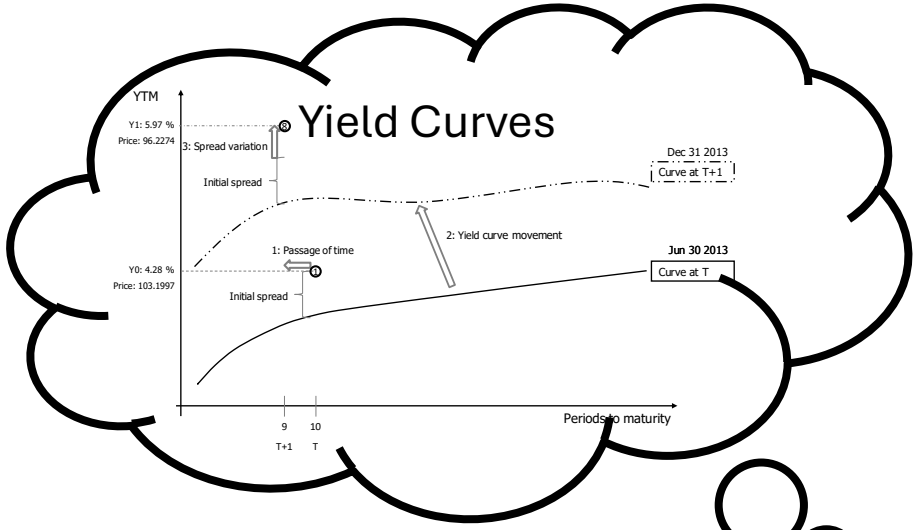
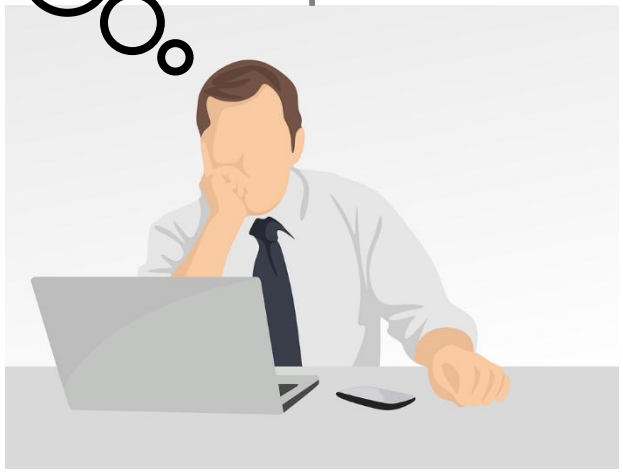
Goal of Performance Attribution

Assess the Investment Decision Process





Predict Yield Curve Movements

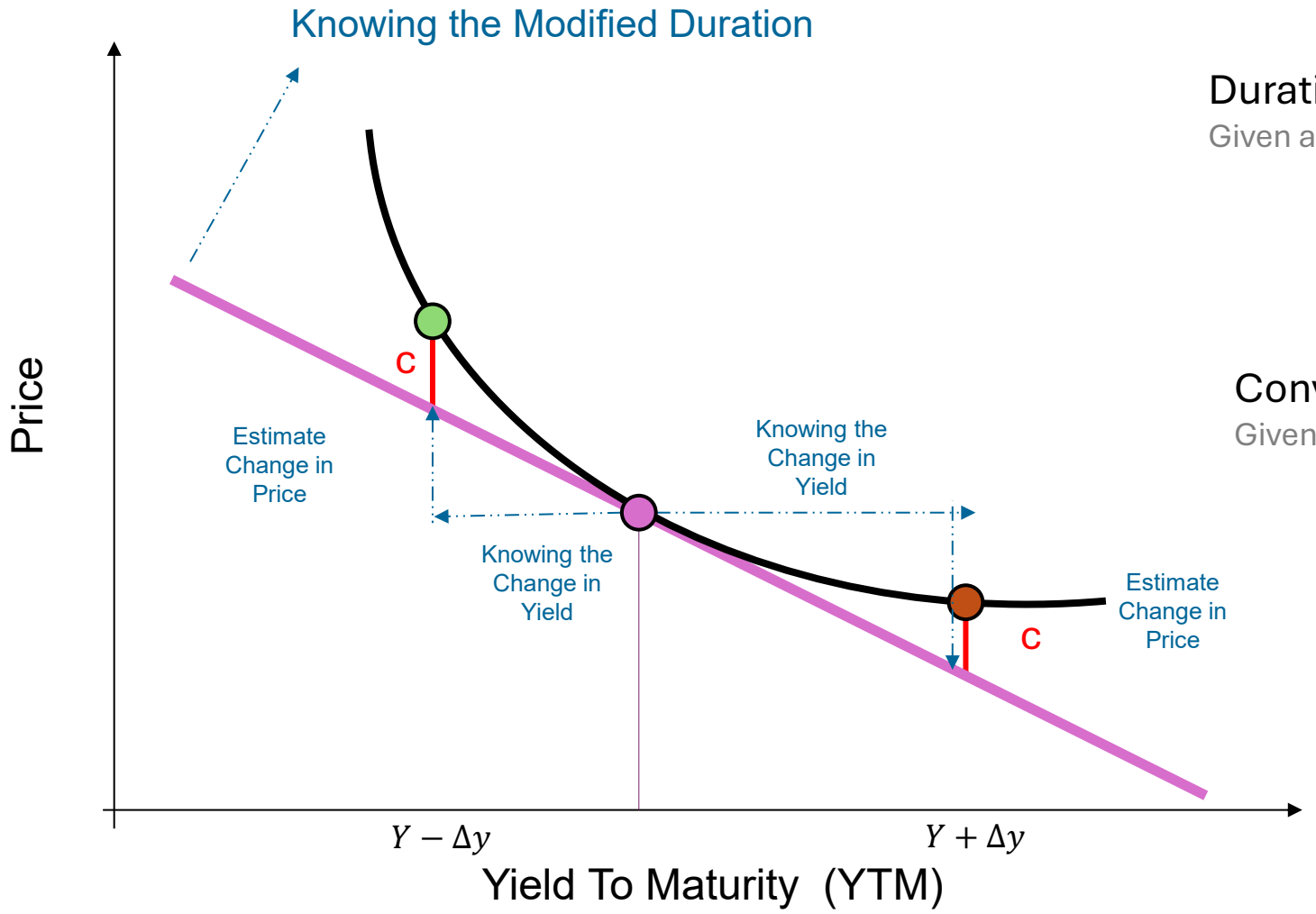
- Shift
- Slope (Twist)
- Shape (Butterfly)
- Spread

≈ **Yield Curve** Decomposition Approach

Make Investment Decisions

- Overall Duration bet
- Yield Curve positioning
- Sector Allocation (Gov., Corp.)
- Credit Allocation (AAA,AA)
- Bond Selection (Yield, Coupon, Issuer)

≈ **Exposure** Decomposition Approach



Duration can estimate the change in price

Given a small change in Yield

$$R^d \approx \frac{\Delta P}{P_0} \approx -D \times \Delta Y$$

Convexity improve the approximation

Given a small change in Yield

$$R^c \approx \frac{1}{2} \times C \times \Delta Y^2$$

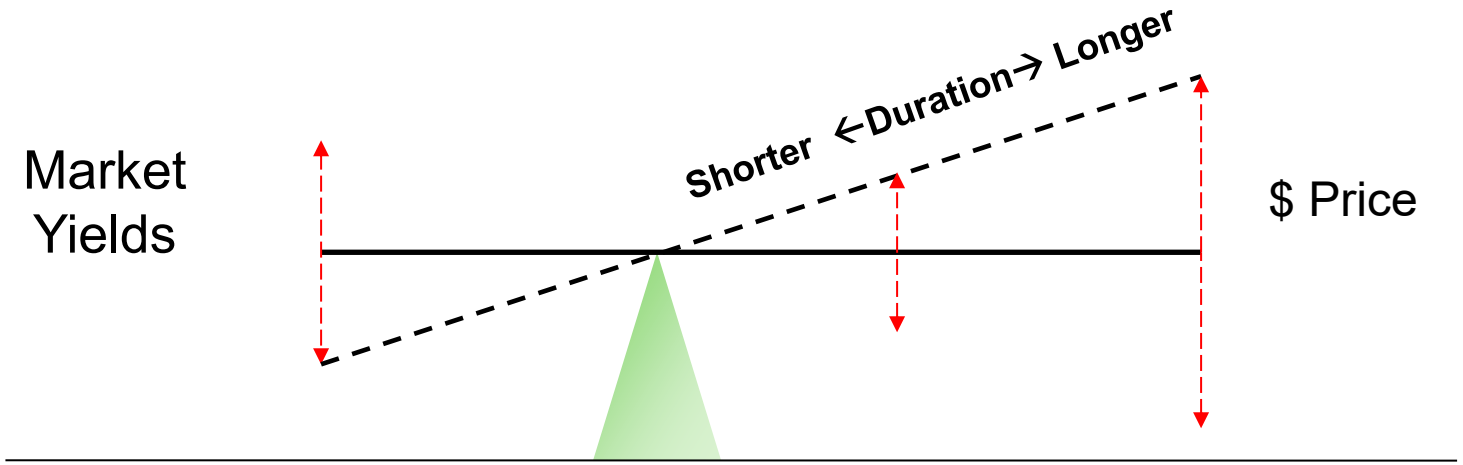
$$R = \frac{\Delta P}{P} \approx R^d + R^c = -D \times \Delta Y + \frac{1}{2} \times C \times \Delta Y^2$$

Modified Duration

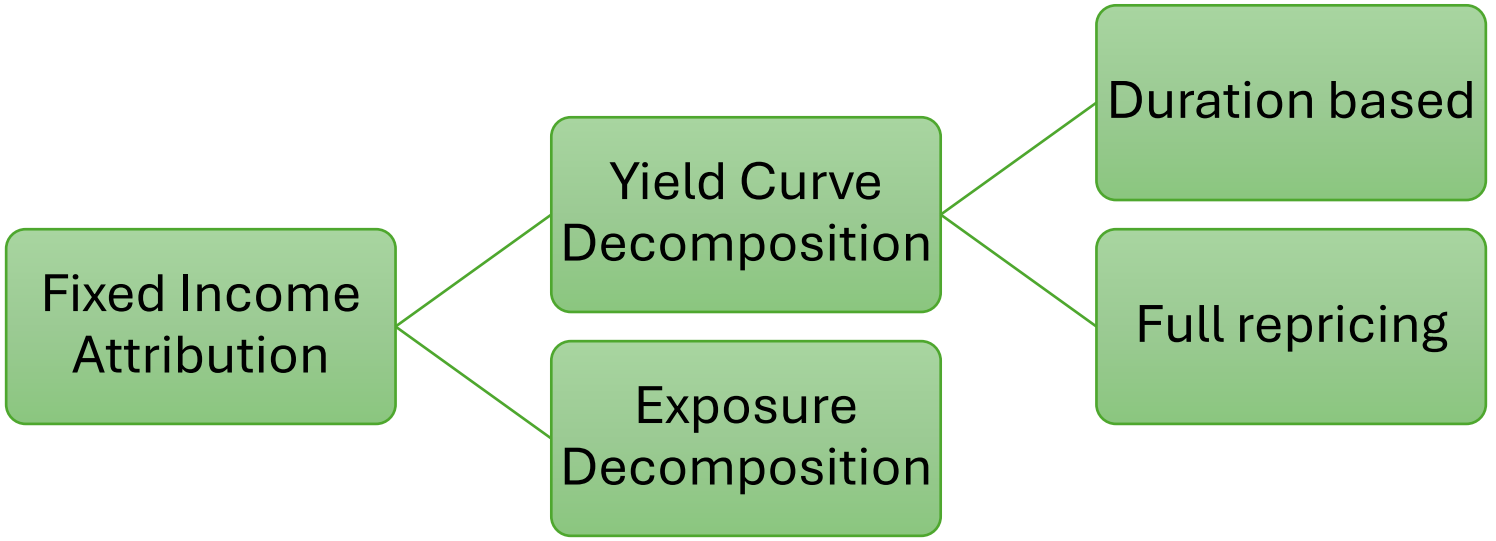
Is a measure of sensitivity to interest rate variations

Relationship

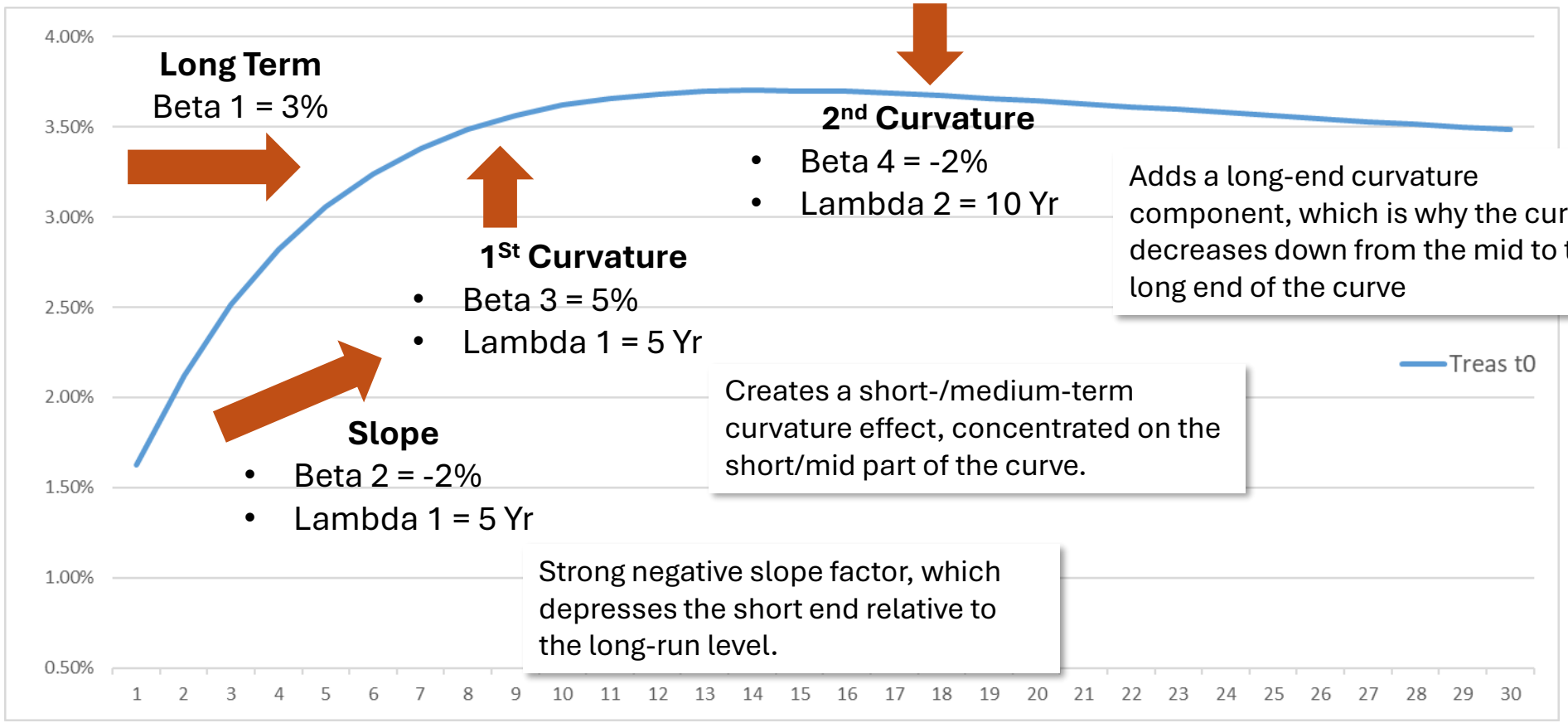
Price, Duration, Market Yields



Fixed Income Attribution Approaches



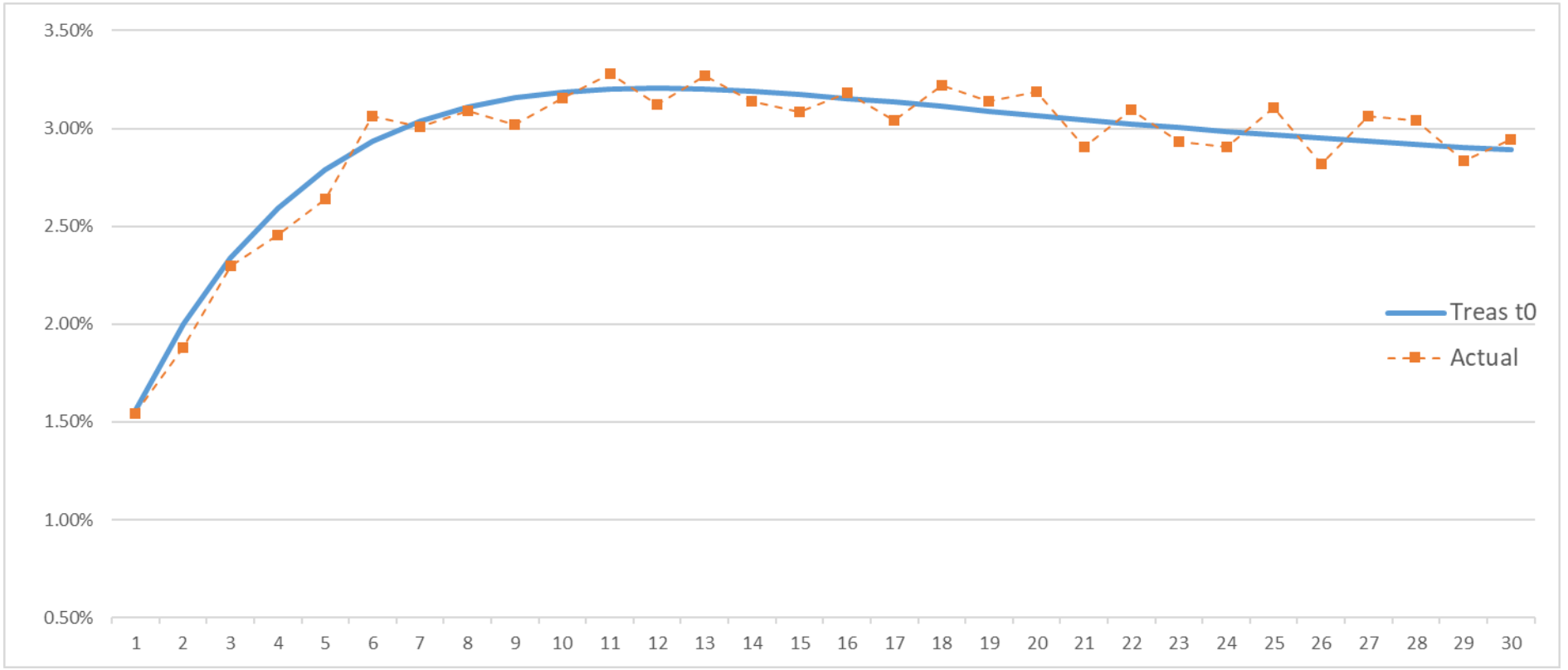
Nelson-Siegel-Svensson Model – Betas and Lambdas



Nelson-Siegel-Svensson Model

Nonlinear least squares optimization
Find optimal **Betas** and **Lambdas** to **minimize** difference between modelled versus actual rates

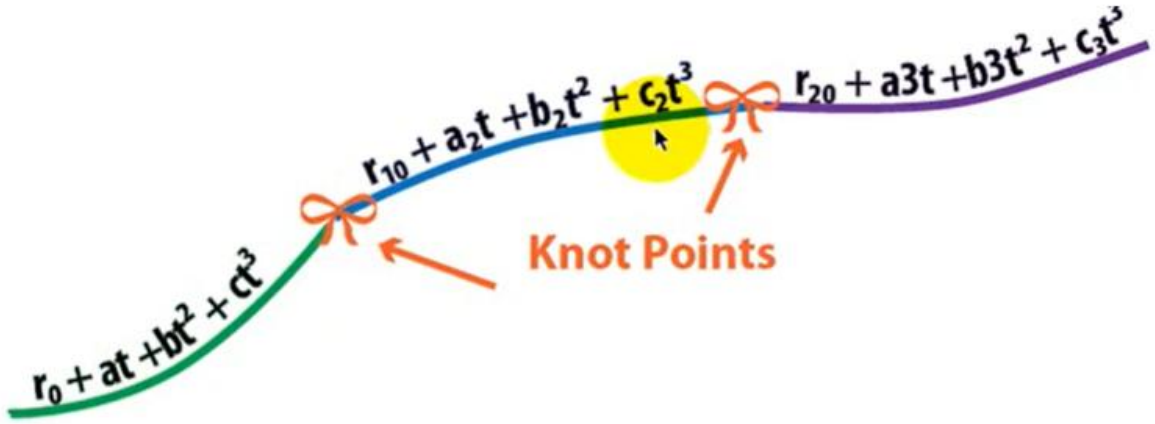
$$y(t) = \beta_1 + \beta_2 \left(\frac{1 - e^{-t/\lambda_1}}{t/\lambda_1} \right) + \beta_3 \left(\frac{1 - e^{-t/\lambda_1}}{t/\lambda_1} - e^{-t/\lambda_1} \right) + \beta_4 \left(\frac{1 - e^{-t/\lambda_2}}{t/\lambda_2} - e^{-t/\lambda_2} \right)$$



Other Curve Fitting Models ?

1. Polynomial / spline-based methods
Cubic splines
•Piecewise polynomials joined at knots

$$\hat{r}(t) = r_o + at + bt^2 + ct^3$$



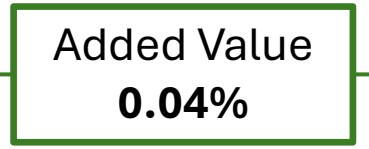
2. Exponential splines (Vasicek–Fong)

$$z(t) = \sum_i a_i \, e^{-b_i t}$$

•Flexible but more parameters
•Precursor to NSS

Any preference or suggestions?

Practical Example



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Issuer	Issue	Base (CAD) Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin
Portfolio PF		**100.00%**	**1.29%**	**1.29%**	**14.97**	**14.97**
Total Sector (Short)		**15.39%**	**0.09%**	**0.59%**	**1.99**	**0.31**
Canada		**7.61%**	**0.02%**	**0.20%**	**1.07**	**0.08**
Corporate		**3.80%**	**0.05%**	**1.40%**	**3.50**	**0.13**
Provincial		**3.98%**	**0.02%**	**0.54%**	**2.30**	**0.09**
Total Sector (Mid)		**31.90%**	**0.34%**	**1.08%**	**7.43**	**2.37**
Canada		**3.82%**	**0.03%**	**0.90%**	**8.53**	**0.33**
Corporate		**10.30%**	**0.04%**	**0.43%**	**7.87**	**0.81**
Provincial		**17.78%**	**0.27%**	**1.49%**	**6.94**	**1.23**
Total Sector (Long)		**52.71%**	**0.86%**	**1.63%**	**23.33**	**12.30**
Canada		**40.86%**	**0.55%**	**1.35%**	**25.34**	**10.35**
Provincial		**11.84%**	**0.30%**	**2.57%**	**16.42**	**1.94**

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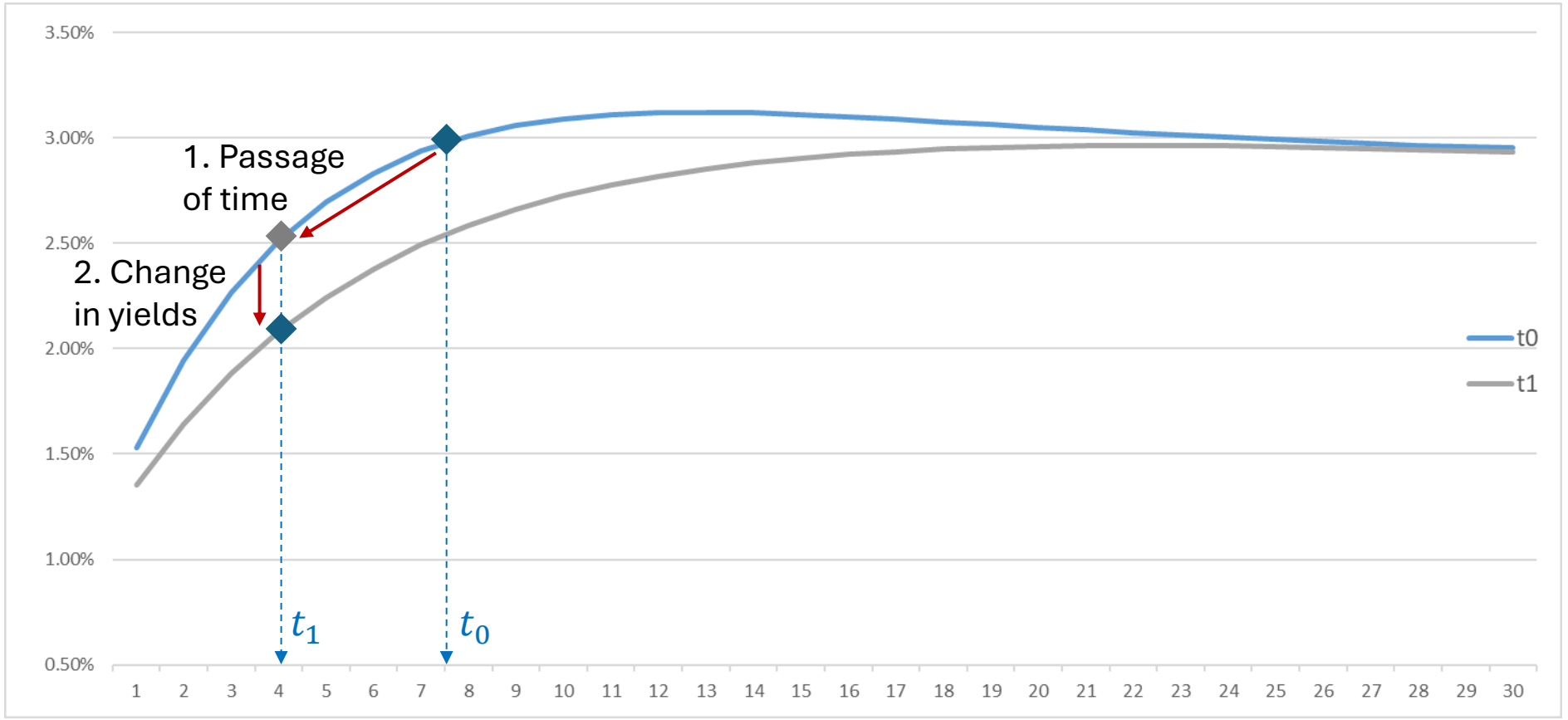
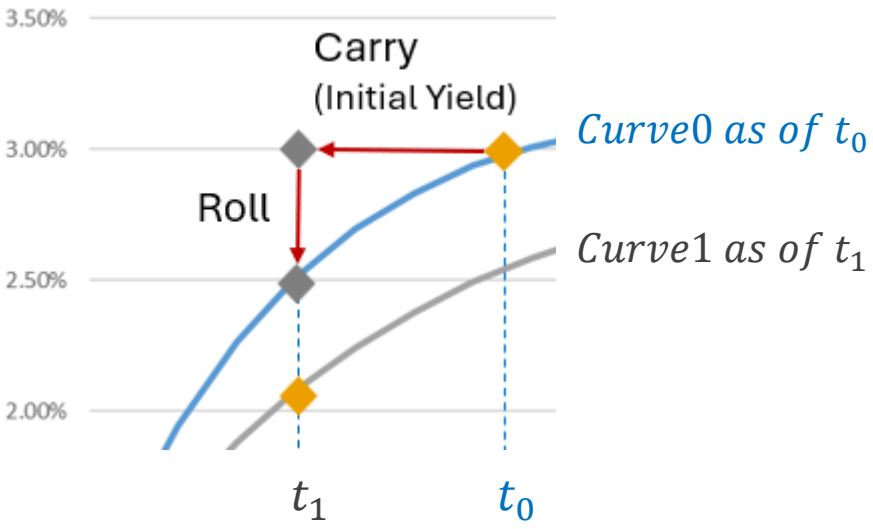
Issuer	Issue	Base (CAD) Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin
Benchmark BM		**100.00%**	**1.25%**	**1.25%**	**11.61**	**11.61**
Total Sector (Short)		**21.36%**	**0.16%**	**0.75%**	**2.29**	**0.49**
Canada		**8.47%**	**0.02%**	**0.20%**	**1.07**	**0.09**
Corporate		**8.46%**	**0.12%**	**1.40%**	**3.50**	**0.30**
Provincial		**4.43%**	**0.02%**	**0.54%**	**2.30**	**0.10**
Total Sector (Mid)		**36.92%**	**0.37%**	**0.99%**	**8.00**	**2.95**
Canada		**21.29%**	**0.19%**	**0.90%**	**8.53**	**1.82**
Corporate		**5.73%**	**0.02%**	**0.43%**	**7.87**	**0.45**
Provincial		**9.90%**	**0.15%**	**1.49%**	**6.94**	**0.69**
Total Sector (Long)		**41.72%**	**0.73%**	**1.74%**	**19.57**	**8.16**
Canada		**23.37%**	**0.28%**	**1.20%**	**22.82**	**5.33**
Provincial		**18.35%**	**0.45%**	**2.43%**	**15.42**	**2.83**

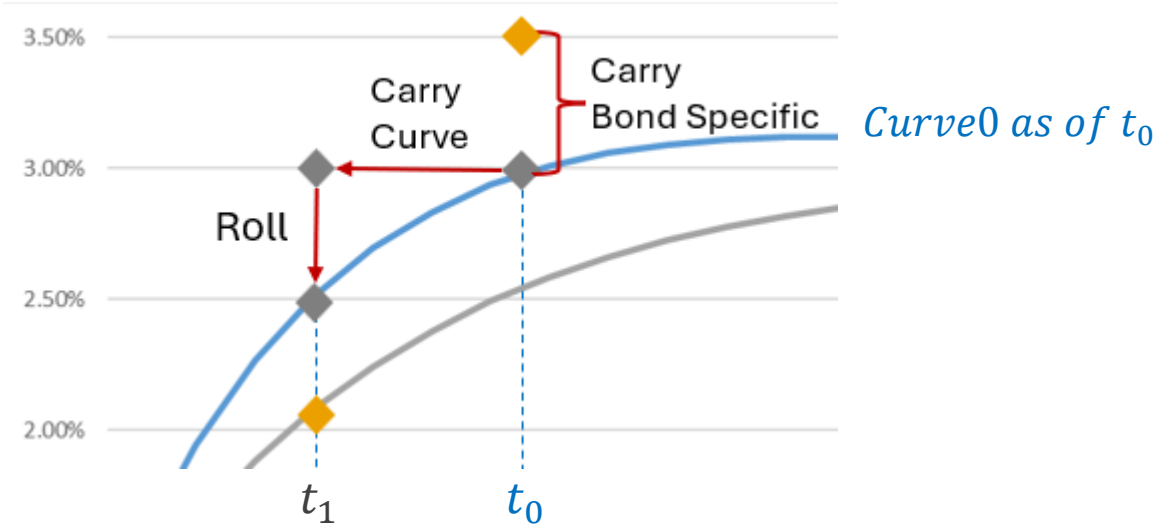
What impacts (contributes to) the return of a bond?



Passage of time

- Carry
- Yield change due to Roll

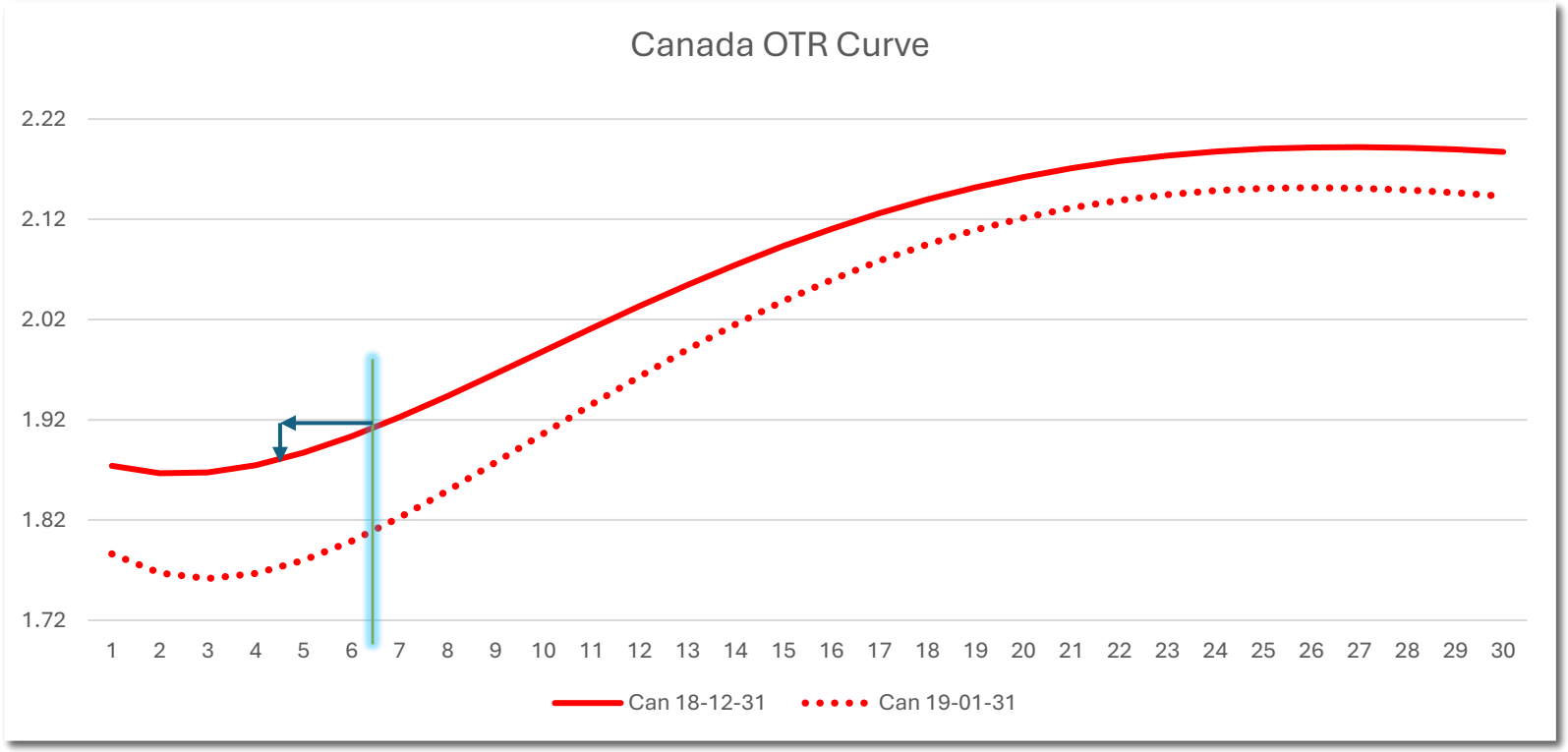


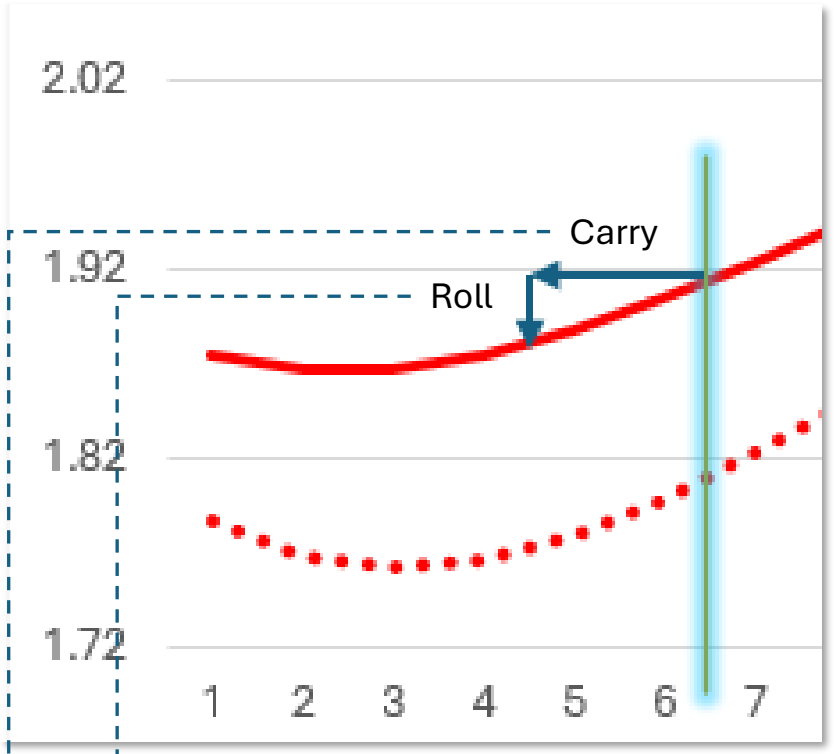


Yield Change due to Roll

$$\Delta Y^{Roll} = Y_{t_1}^{C_0} - Y_{t_0}^{C_0} = 2.50\% - 3.00\% = -0.50\%$$

Passage of time – Roll and Carry





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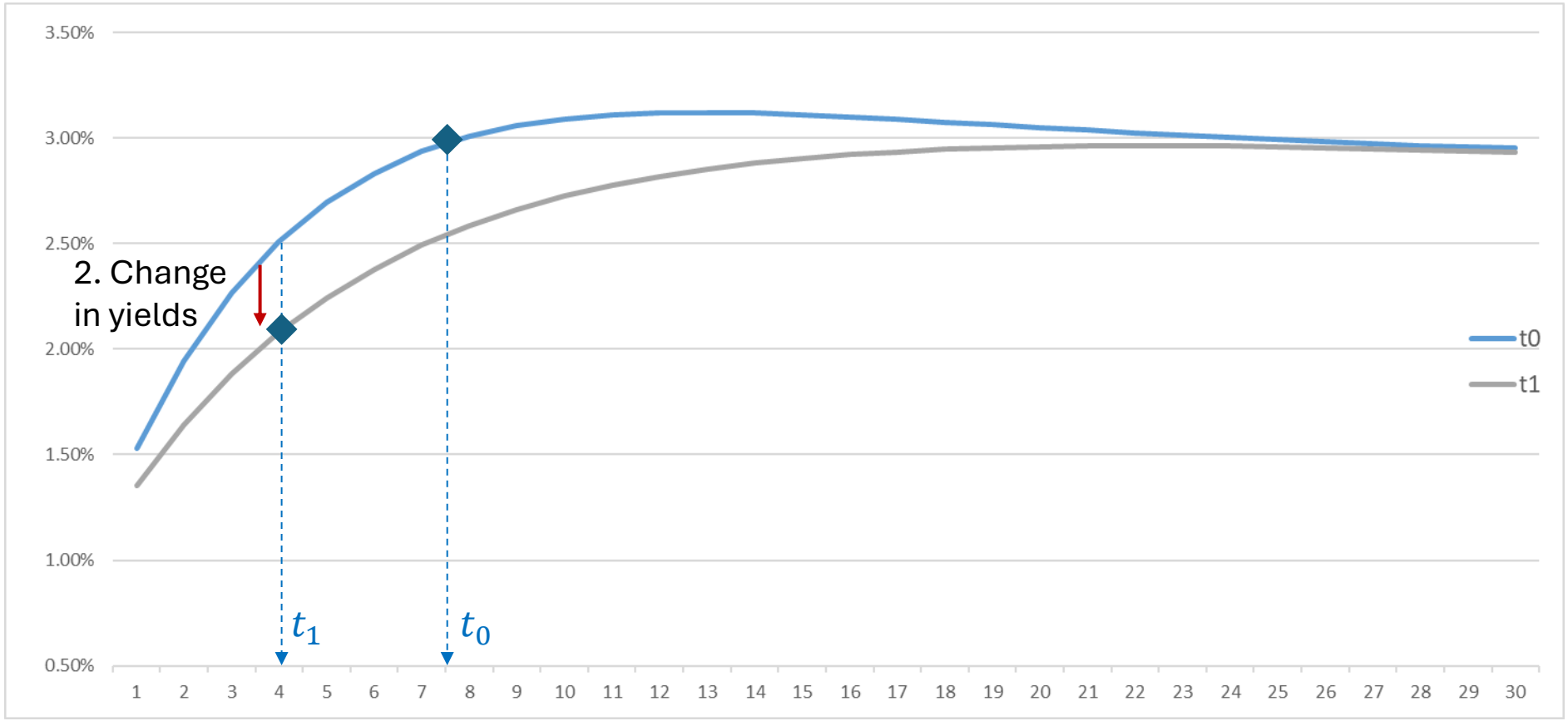
Issuer	Issue	Level	Duration	Convx	Term Begin	Performance Base Return	Performance Local Return	Curve Movement Roll	Curve Movement Shift	Curve Movement Twist	Curve Movement Ccy	Effect on Bond Return Carry	Effect on Bond Return Roll	Effect on Bond Return Shift	Effect on Bond Return Twist	Effect on Bond Return Carry Specific	Effect on Bond Return Trade	Effect on Bond Return Specific	Effect on Bond Return Total
ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**5.86**	**0.39**	**6.4**	**1.35%**	**1.35%**	**-**	**-**	**-**	**-**	**0.22%**	**0.04%**	**0.91%**	**0.19%**	**-0.00%**	**-**	**-0.01%**	**1.35%**
ONTARIO PROV	2.600 JUN 02 25	Can OTR	5.86	0.39	6.4	1.35%	1.35%	-0.002%	-0.065%	-0.039%	-	0.16%	0.01%	0.38%	0.23%	-	-	-	0.78%
ONTARIO PROV	2.600 JUN 02 25	Provincial	5.86	0.39	6.4	1.35%	1.35%	-0.006%	-0.090%	0.007%	-	0.06%	0.03%	0.53%	-0.04%	-0.00%	-	-0.01%	0.58%

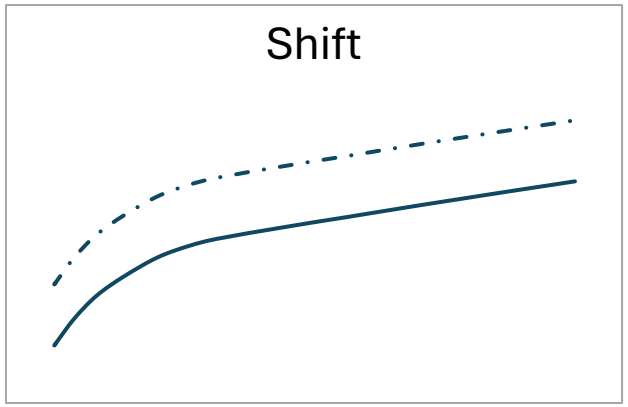
Change in Yield Curve

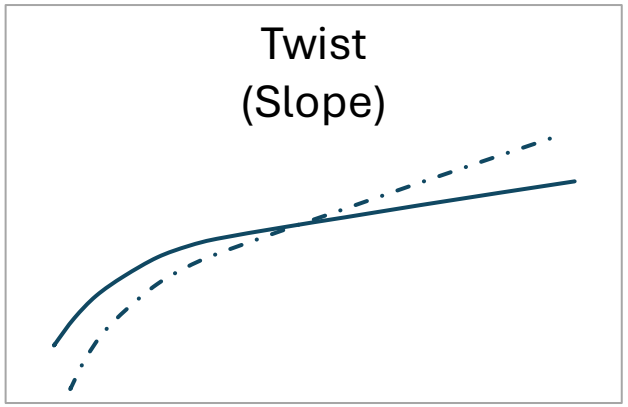


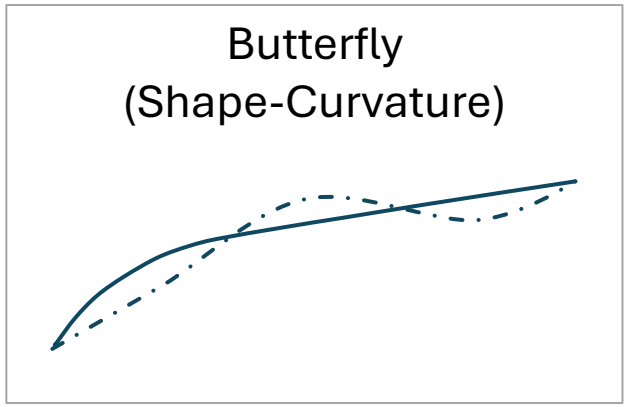
Change in Yield Curve

Reference Curve (Can OTR)

Yield

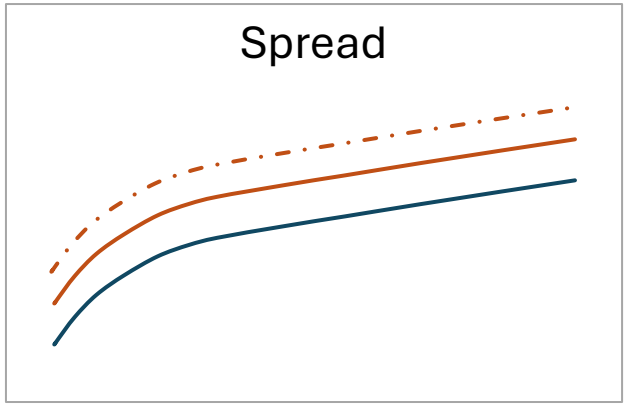


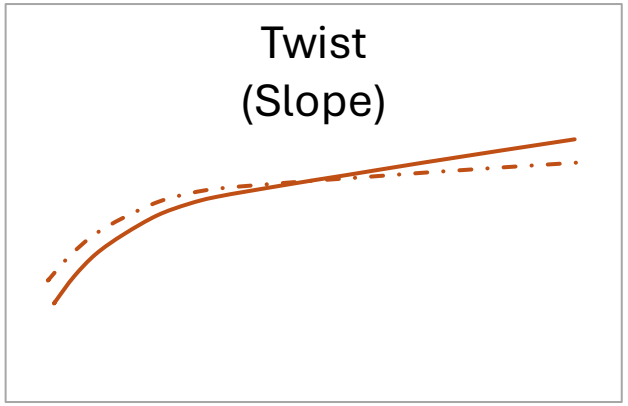


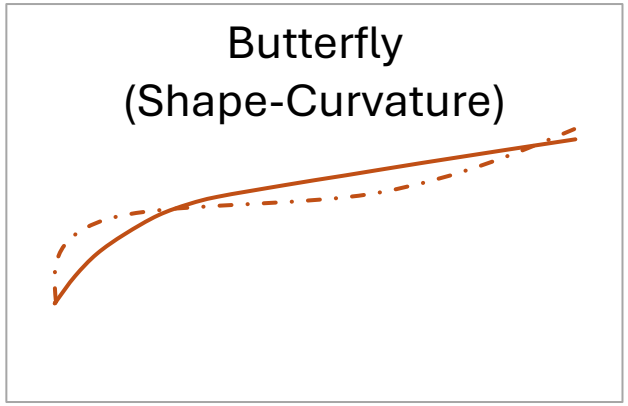


Years to Maturity

Credit Curve (Corporate)

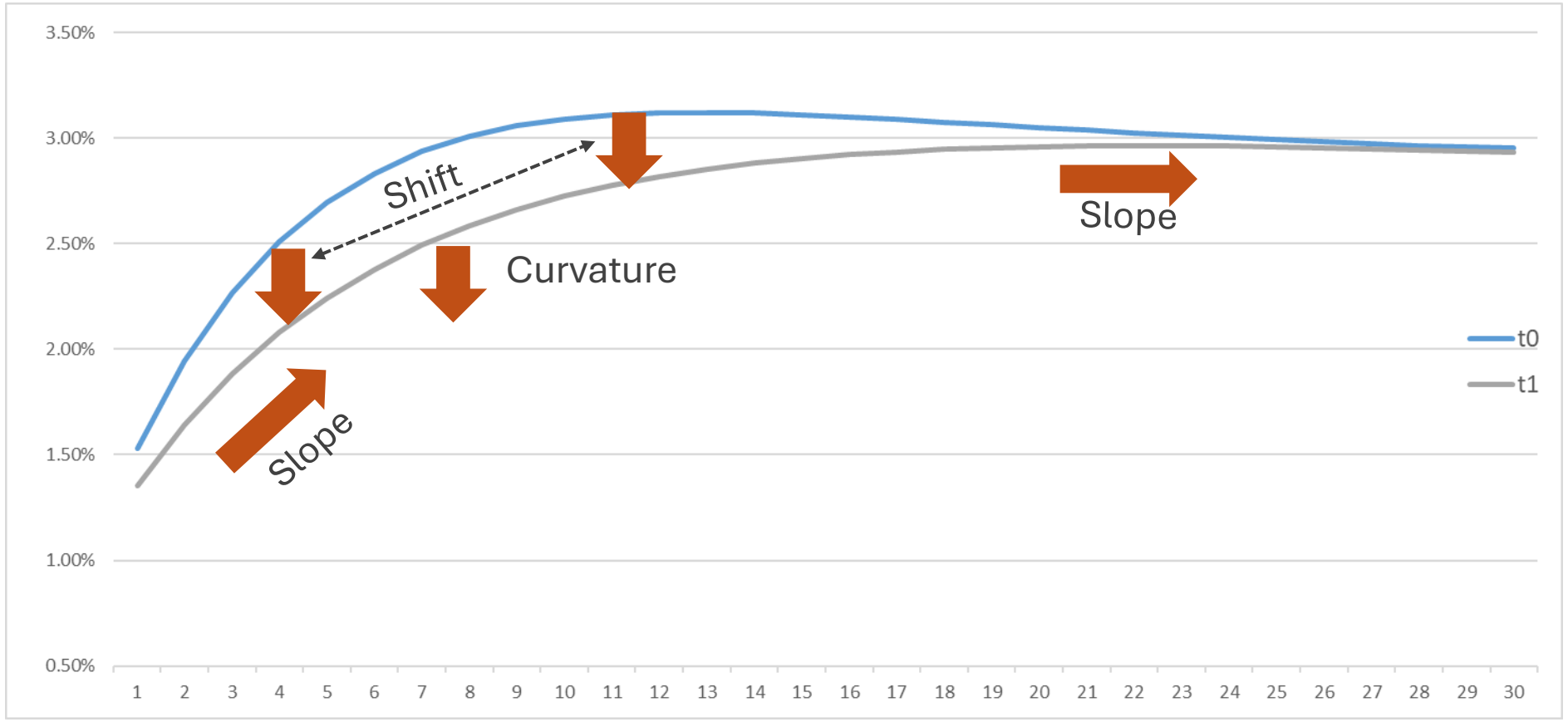


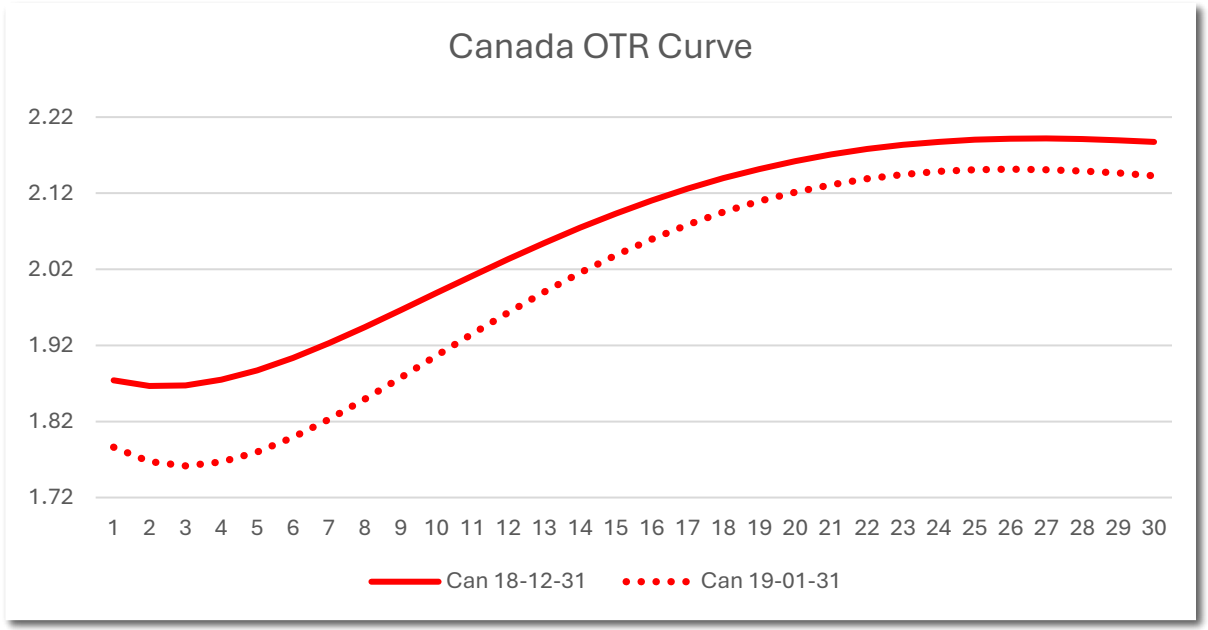




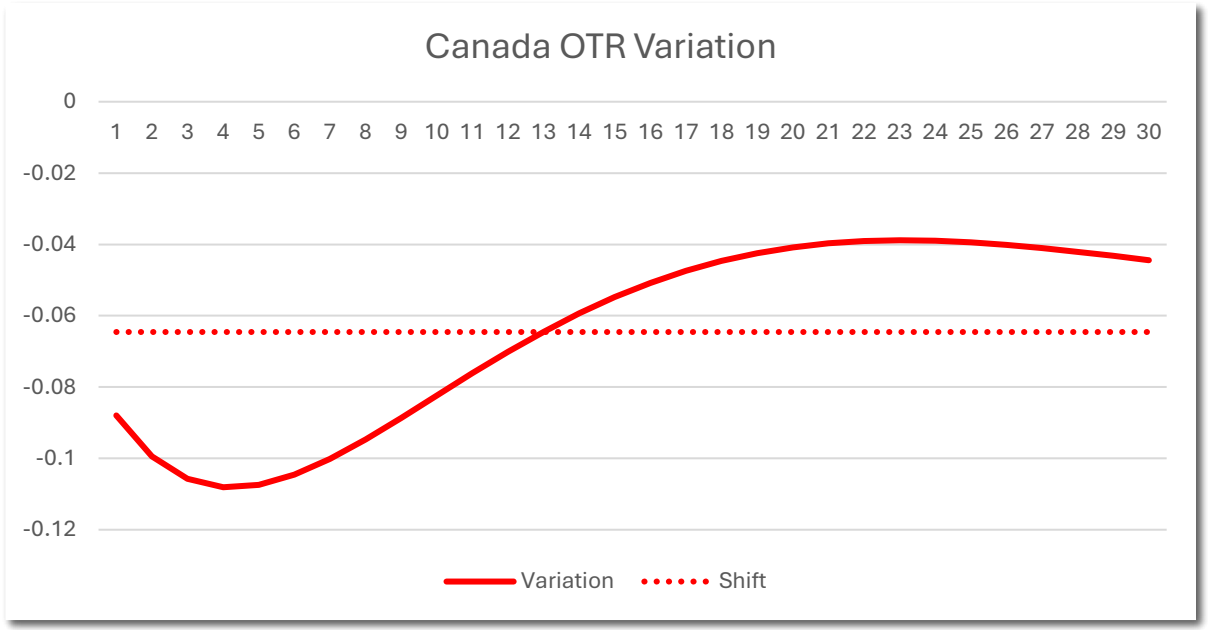
Yield Curve Movements

1. Shift (Average, Parallel)
2. Twist (Slope) & Butterfly (Curvature)

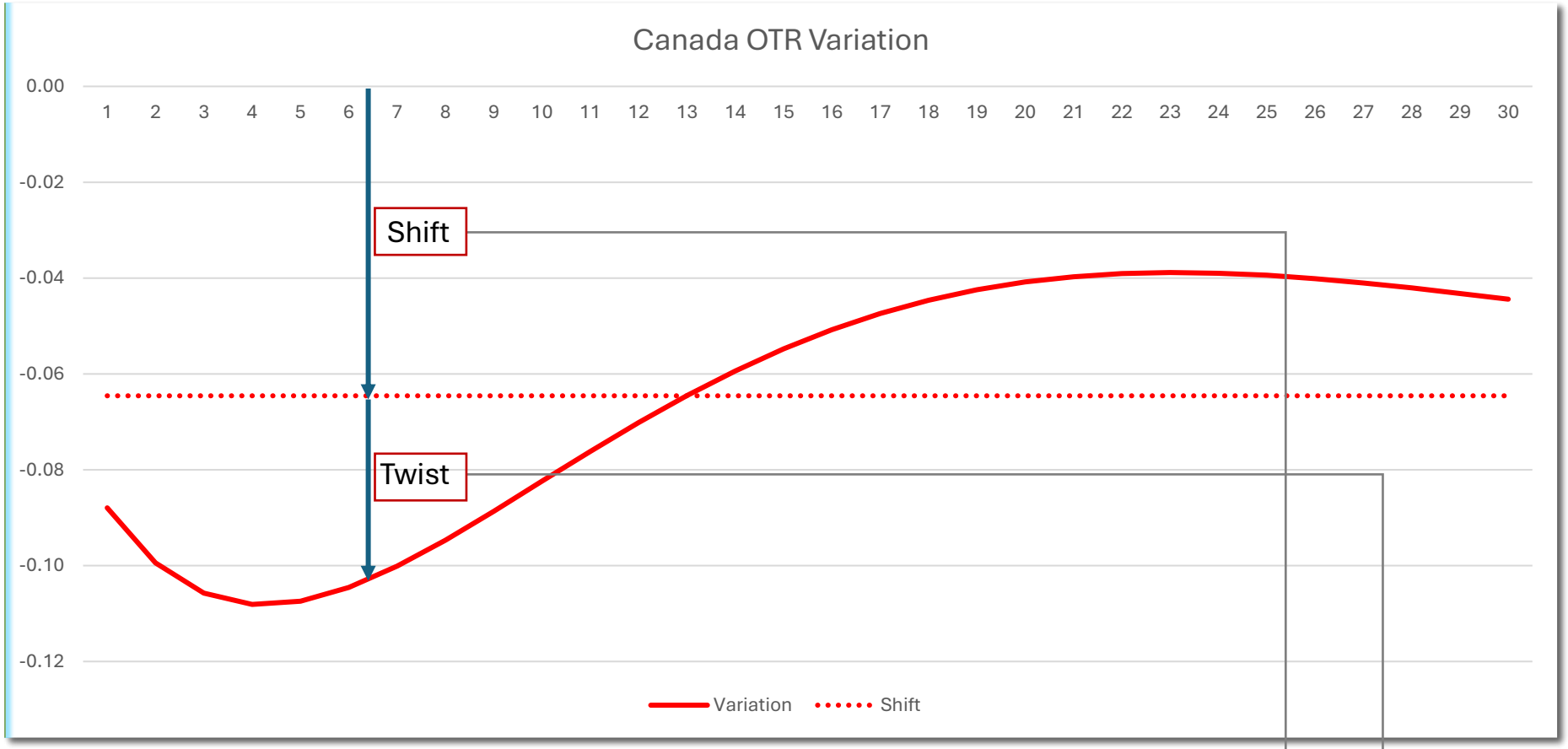




Curve at t0 and t1



Variation t0 → t1



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ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**5.86**	**0.39**	**6.4**	**1.35%**	**1.35%**	**-**	**-**	**-**	**-**	**0.22%**	**0.04%**	**0.91%**	**0.19%**	**-0.00%**	**-**	**-0.01%**	**1.35%**
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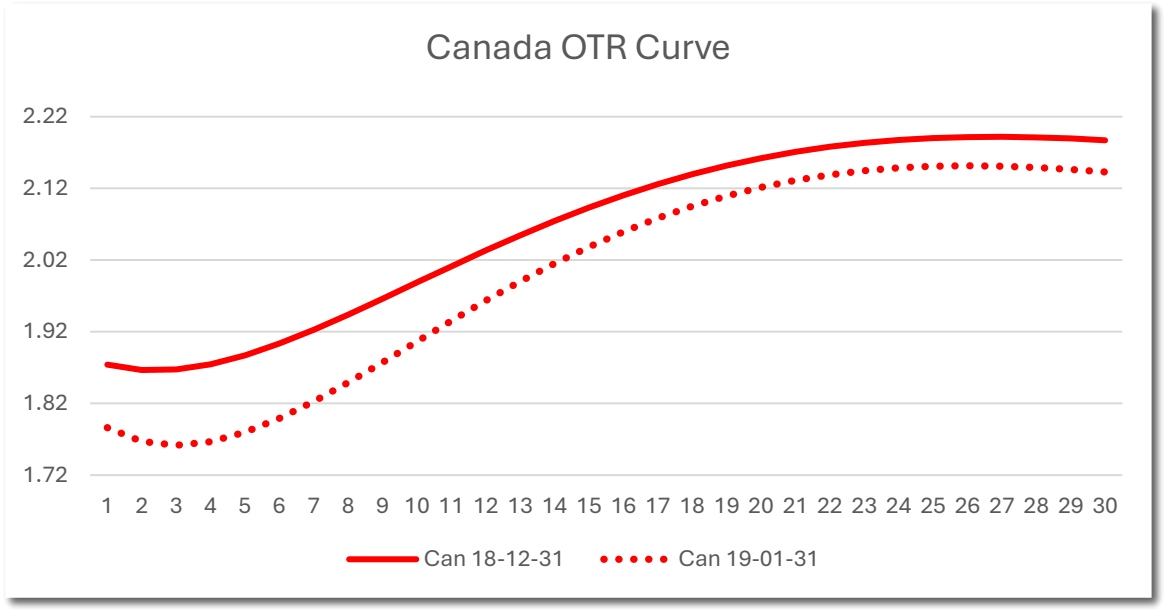
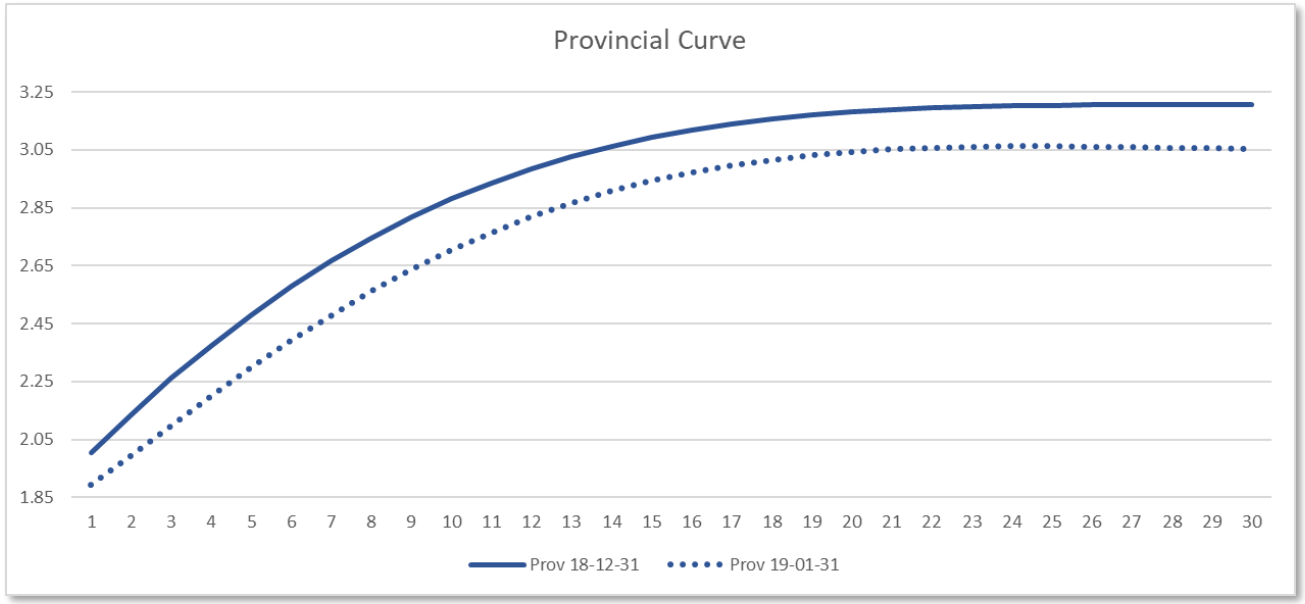
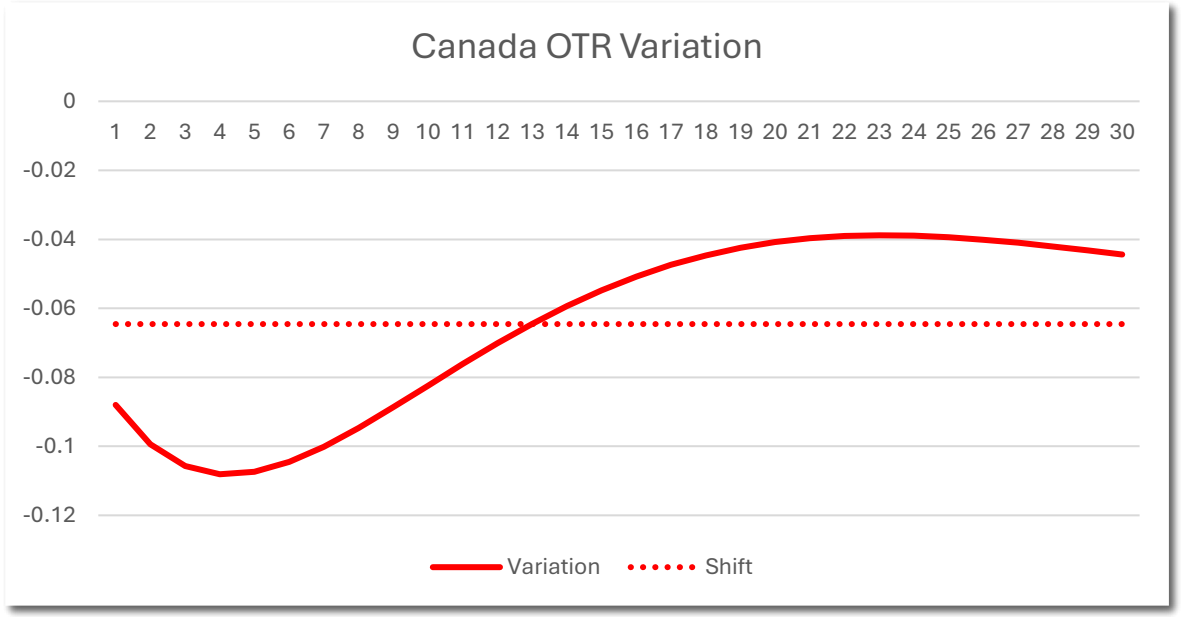
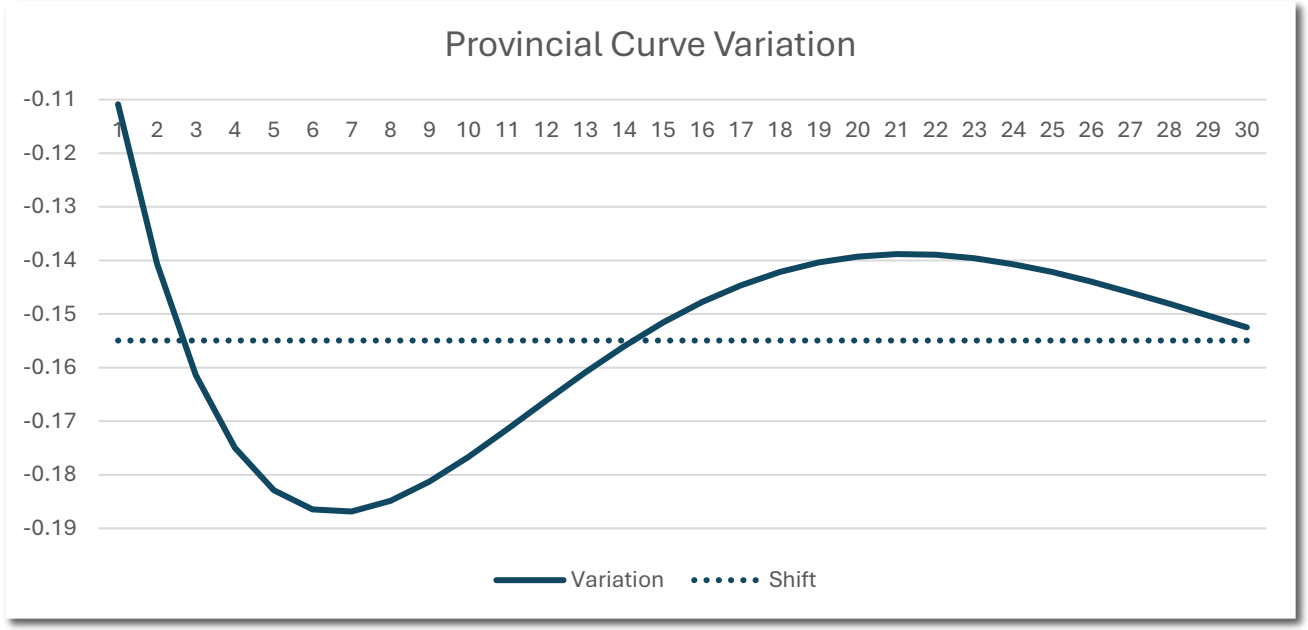
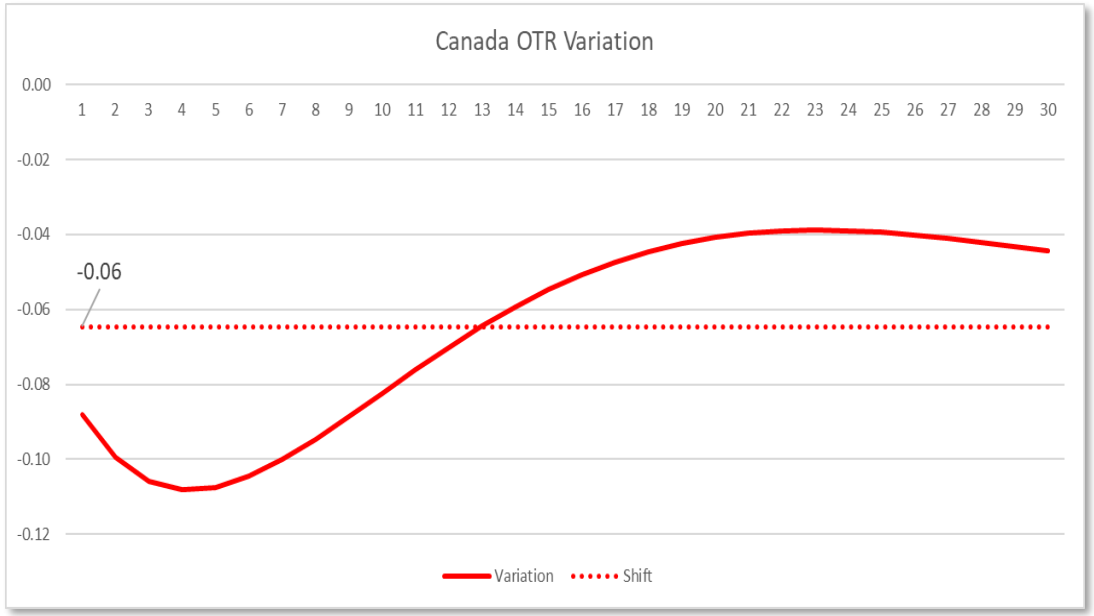
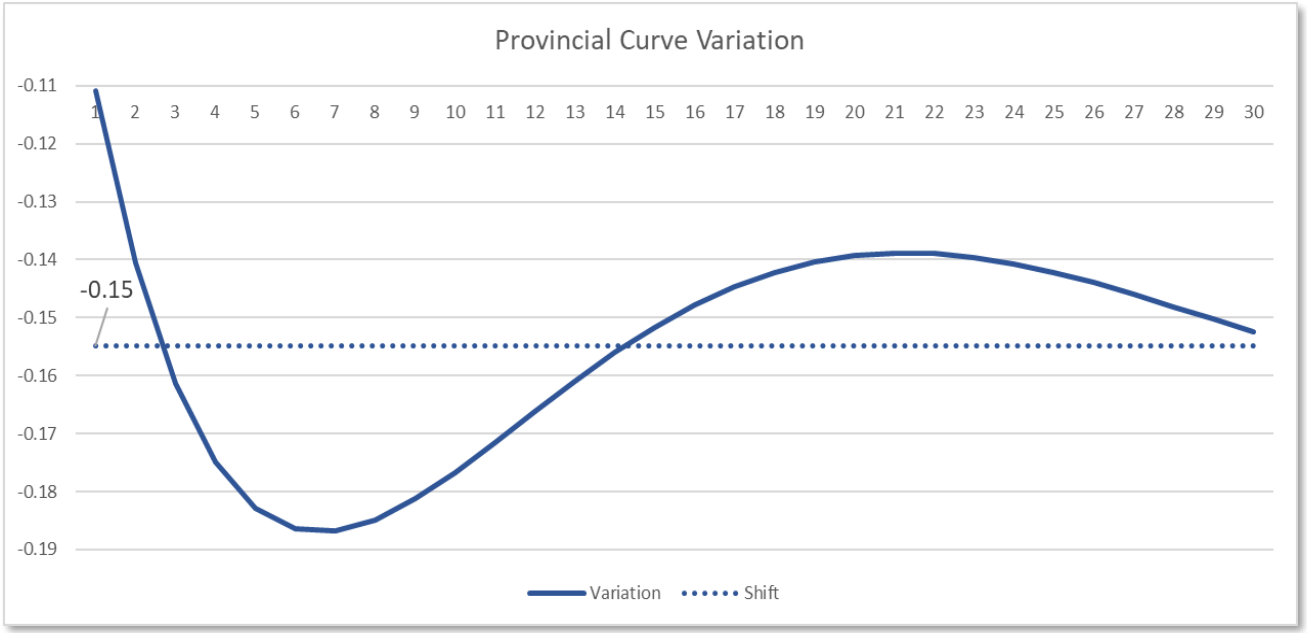

Canada OTR Curve
2.22
2.12
2.02
1.92
1.82
1.72
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Can 18-12-31
Can 19-01-31

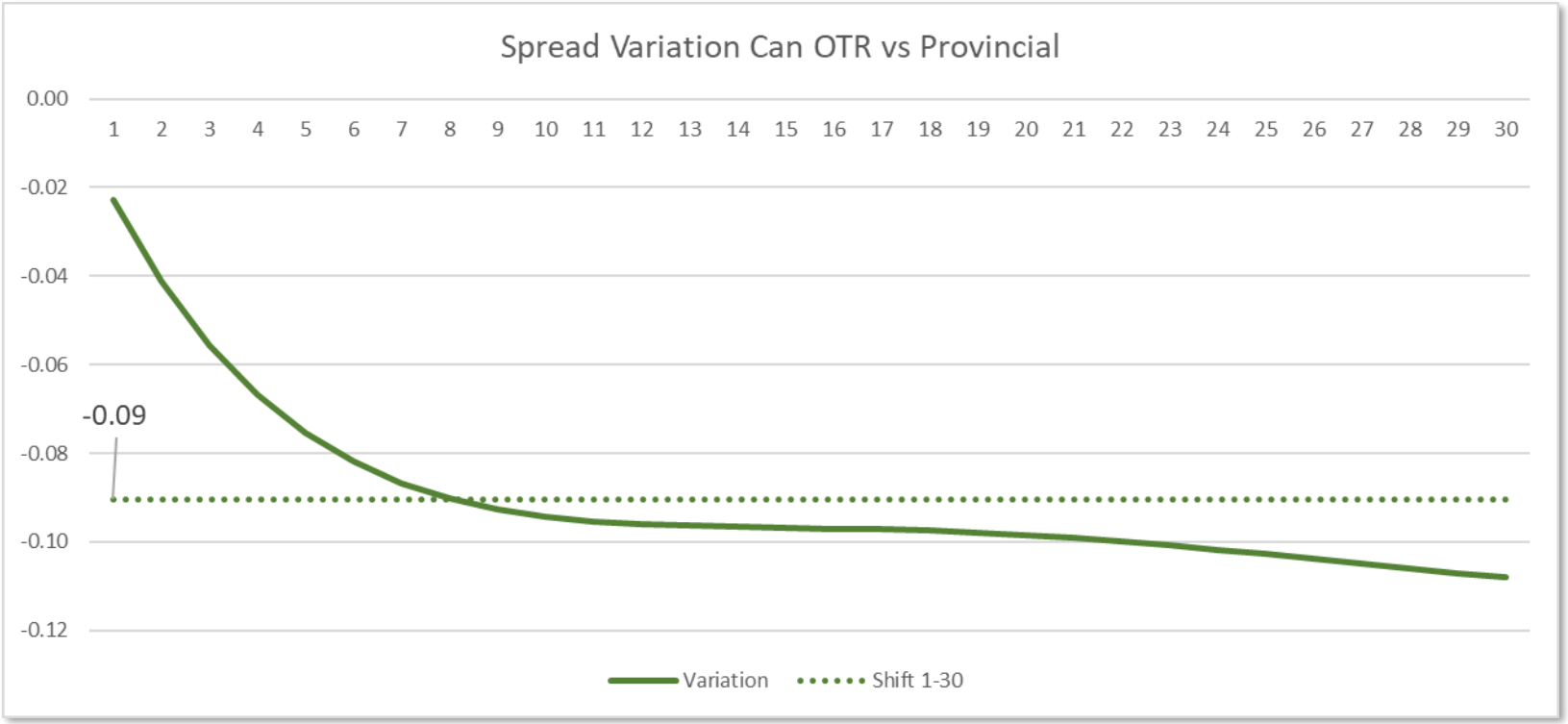

Provincial Curve
3.25
3.05
2.85
2.65
2.45
2.25
2.05
1.85
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Prov 18-12-31
Prov 19-01-31

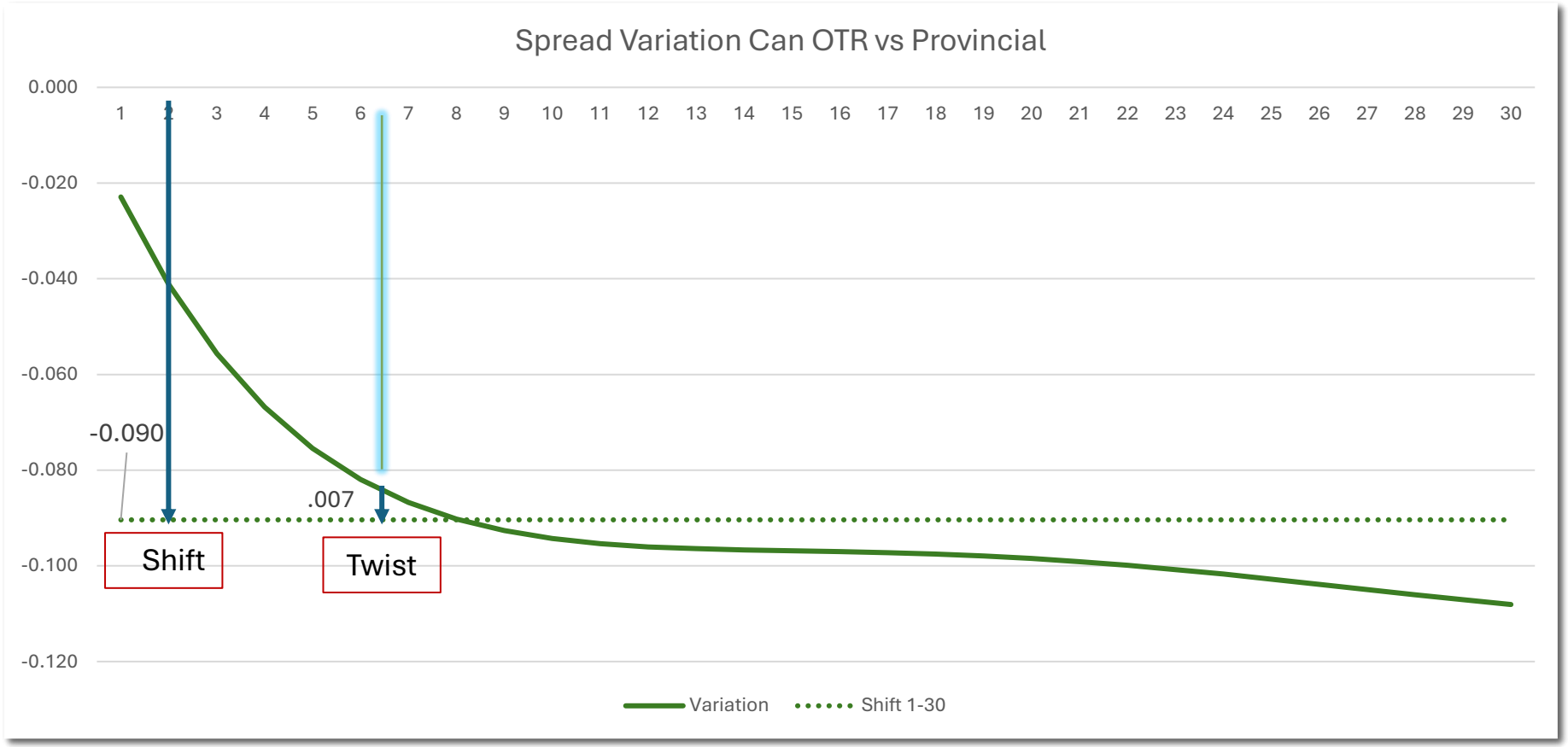

Canada OTR Variation
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Variation
Shift


Provincial Curve Variation
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Variation
Shift


Canada OTR Variation
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-0.06
Variation
Shift


Provincial Curve Variation
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-0.15
Variation
Shift


Spread Variation Can OTR vs Provincial
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
-0.09
Variation
Shift 1-30



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						Performance		Curve Movement				Effect on Bond Return							
Issuer	Issue	Level	Duration	Convx	Term Begin	Base Return	Local Return	Roll	Shift	Twist	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**5.86**	**0.39**	**6.4**	**1.35%**	**1.35%**	**-**	**-**	**-**	**-**	**0.22%**	**0.04%**	**0.91%**	**0.19%**	**-0.00%**	**-**	**-0.01%**	**1.35%**
ONTARIO PROV	2.600 JUN 02 25	Can OTR	5.86	0.39	6.4	1.35%	1.35%	-0.002%	-0.065%	-0.039%	-	0.16%	0.01%	0.38%	0.23%	-	-	-	0.78%
ONTARIO PROV	2.600 JUN 02 25	Provincial	5.86	0.39	6.4	1.35%	1.35%	-0.006%	-0.090%	0.007%	-	0.06%	0.03%	0.53%	-0.04%	-0.00%	-	-0.01%	0.58%

Measures curves impacts on bonds'...

Return

Powered by Robust Technologies -

Effect on Bond Return

Issuer	Issue	Level	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
		Total	**-**	**0.22%**	**0.02%**	**1.42%**	**-0.16%**	**0.00%**	**-**	**-0.21%**	**1.29%**
ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**-**	**0.22%**	**0.04%**	**0.91%**	**0.19%**	**-0.00%**	**-**	**-0.01%**	**1.35%**
ONTARIO PROV	2.600 JUN 02 25	Can OTR	-	0.16%	0.01%	0.38%	0.23%	-	-	-	0.78%
ONTARIO PROV	2.600 JUN 02 25	Provincial	-	0.06%	0.03%	0.53%	-0.04%	-0.00%	-	-0.01%	0.58%

Contribution

Powered by Robust Technologies -

Contribution

Issuer	Issue	Level	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
		Total	**-**	**0.22%**	**0.02%**	**1.42%**	**-0.16%**	**0.00%**	**-**	**-0.21%**	**1.29%**
ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**-**	**0.02%**	**0.00%**	**0.07%**	**0.01%**	**-0.00%**	**-**	**-0.00%**	**0.10%**
ONTARIO PROV	2.600 JUN 02 25	Can OTR	-	0.01%	0.00%	0.03%	0.02%	-	-	-	0.06%
ONTARIO PROV	2.600 JUN 02 25	Provincial	-	0.00%	0.00%	0.04%	-0.00%	-0.00%	-	-0.00%	0.04%

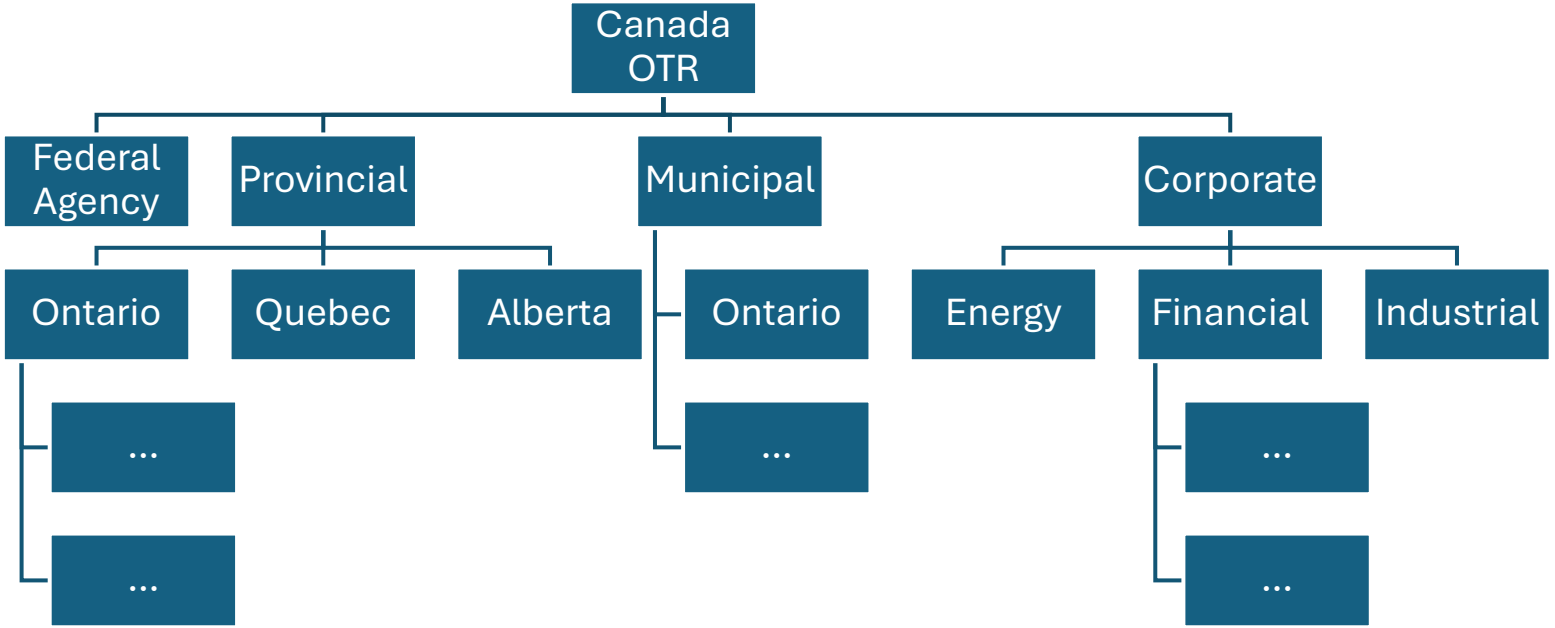
Dollar Earned

Powered by Robust Technologies -

$ Earned

Issuer	Issue	Level	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
		Total	**-**	**57,740**	**3,968**	**373,298**	**-41,730**	**1,310**	**-**	**-55,293**	**339,293**
ONTARIO PROV	**2.600 JUN 02 25**	**Total**	**-**	**4,447**	**888**	**18,166**	**3,748**	**-29**	**-**	**-142**	**27,076**
ONTARIO PROV	2.600 JUN 02 25	Can OTR	-	3,248	189	7,569	4,529	-	-	-	15,534
ONTARIO PROV	2.600 JUN 02 25	Provincial	-	1,199	699	10,597	-781	-29	-	-142	11,542

Can define any Curves Hierarchy



Calculations done

- For every bonds in portfolio and benchmark
- For every relevant curves
  - Reference curve e.g. Can OTR relevant for all bonds
  - Specific curves e.g. Provincial, Corporate, and lower curves
- Summed up at curve levels
- Every day
- Compound daily results over longer periods (Month, Year, etc.)

Pow ered by Robust Technologies -		Performance			Contribution								
Desc.	Level	Return	Duration	Term End	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
Portfolio PF	**Total**	**1.29%**	**14.97**	**22.1**	**-**	**0.22%**	**0.02%**	**1.42%**	**-0.16%**	**0.0050%**	**-**	**-0.21%**	**1.29%**
	Can OTR	1.29%	14.97	22.1	-	0.18%	0.00%	0.97%	-0.18%	0.0009%	-	-0.00%	0.97%
	Coporate	0.69%	6.69	9.2	-	0.02%	0.00%	0.16%	-0.00%	0.0040%	-	-0.19%	-0.00%
	Provincial	1.76%	9.73	13.3	-	0.02%	0.01%	0.30%	0.02%	0.0001%	-	-0.02%	0.33%
Benchmark BM	**Total**	**1.25%**	**11.61**	**16.0**	**-**	**0.22%**	**0.02%**	**1.20%**	**-0.07%**	**0.0032%**	**-**	**-0.12%**	**1.25%**
	Can OTR	1.25%	11.61	16.0	-	0.17%	0.01%	0.75%	-0.09%	0.0004%	-	-0.01%	0.83%
	Coporate	1.01%	5.26	6.7	-	0.02%	0.01%	0.13%	-0.01%	0.0026%	-	-0.09%	0.05%
	Provincial	1.89%	11.08	15.5	-	0.02%	0.00%	0.33%	0.03%	0.0003%	-	-0.02%	0.36%
Excess	**Total**	**0.04%**	**3.37**	**6.1**	**-**	**0.00%**	**-0.00%**	**0.22%**	**-0.09%**	**0.0018%**	**-**	**-0.09%**	**0.04%**
	Can OTR	0.04%	3.37	6.1	-	0.00%	-0.00%	0.22%	-0.09%	0.0005%	-	0.01%	0.13%
	Coporate	-0.32%	1.43	2.5	-	0.00%	-0.00%	0.03%	0.01%	0.0014%	-	-0.10%	-0.06%
	Provincial	-0.13%	-1.34	-2.2	-	-0.00%	0.00%	-0.03%	-0.01%	-0.0002%	-	0.00%	-0.04%

Yield Curve Top-Down Analysis - Contribution

	Powered by Robust Technologies -				Performance	Contribution							
	Sec Id	Issuer	Issue	Level	Base Return	Ccy	Carry	Roll	Shift	Twist	Carry Specific	Trade	Specific	Total
				Total	**1.29%**	**-**	**0.22%**	**0.02%**	**1.42%**	**-0.16%**	**0.00%**	**-**	**-0.21%**	**1.29%**
				Can OTR	**1.29%**	**-**	**0.18%**	**0.00%**	**0.97%**	**-0.18%**	**0.00%**	**-**	**-0.00%**	**0.97%**
				Coporate	**0.69%**	**-**	**0.02%**	**0.00%**	**0.16%**	**-0.00%**	**0.00%**	**-**	**-0.19%**	**-0.00%**
				Provincial	**1.76%**	**-**	**0.02%**	**0.01%**	**0.30%**	**0.02%**	**0.00%**	**-**	**-0.02%**	**0.33%**
	68323ACX0	ONTARIO PROV	2.600 JUN 02 25	Provincial	1.35%	-	0.00%	0.00%	0.04%	-0.00%	-0.00%	-	-0.00%	0.04%
	68323ACY8	ONTARIO PROV	2.900 DEC 02 46	Provincial	2.89%	-	0.01%	0.00%	0.12%	0.02%	-0.00%	-	-0.01%	0.14%
	68323AAD6	ONTARIO PROV	21Jun02	Provincial	0.54%	-	0.00%	0.00%	0.01%	-0.00%	0.00%	-	-0.00%	0.01%
	683234YD4	ONTARIO PROV	4.700 JUN 02 37	Provincial	2.07%	-	0.00%	0.00%	0.05%	0.00%	0.00%	-	-0.00%	0.06%
	683234LJ5	ONTARIO PROV	6.500 MAR 08 29	Provincial	1.60%	-	0.01%	0.00%	0.07%	0.00%	0.00%	-	-0.01%	0.08%

Exposure Decomposition Approach

- Exposure is defined as **Duration Contribution**
- **Yield Changes** implied from **Returns**

Equity Attribution

- Overexpose (**Weight**)
- Segments (e.g. sectors) that outperform (**Return**)

Fixed Income Attribution

- Overexpose (**Duration Contribution**)
- Segments (e.g. Maturity buckets, Sectors, etc.) that outperform (**Yield Change / Duration**)

Implied Yield Change: ΔY

Return Local = Cash Short Risk Free Rate + Duration x $-\Delta Y$

$$R = rf + (-D \times \Delta Y)$$

ΔY = - (Return Local - Cash Short Risk Free Rate) / Duration

$$\Delta Y = -\frac{R - rf}{D}$$

Exposure Decomposition Approach

Powered by Robust Technologies -		Base (CAD)			Duration		
Issuer	Issue	Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin	Yield Change
Portfolio PF		**100.00%**	**1.29%**	**1.29%**	**14.97**	**14.97**	**-0.09%**
Total Sector (Short)		**15.39%**	**0.09%**	**0.59%**	**1.99**	**0.31**	**-0.29%**
Canada		7.61%	0.02%	0.20%	1.07	0.08	-0.19%
Corporate		3.80%	0.05%	1.40%	3.50	0.13	-0.40%
Provincial		3.98%	0.02%	0.54%	2.30	0.09	-0.24%
Total Sector (Mid)		**31.90%**	**0.34%**	**1.08%**	**7.43**	**2.37**	**-0.15%**
Canada		3.82%	0.03%	0.90%	8.53	0.33	-0.11%
Corporate		10.30%	0.04%	0.43%	7.87	0.81	-0.05%
Provincial		17.78%	0.27%	1.49%	6.94	1.23	-0.22%
Total Sector (Long)		**52.71%**	**0.86%**	**1.63%**	**23.33**	**12.30**	**-0.07%**
Canada		40.86%	0.55%	1.35%	25.34	10.35	-0.05%
Provincial		11.84%	0.30%	2.57%	16.42	1.94	-0.16%

Exposure

Yield Change

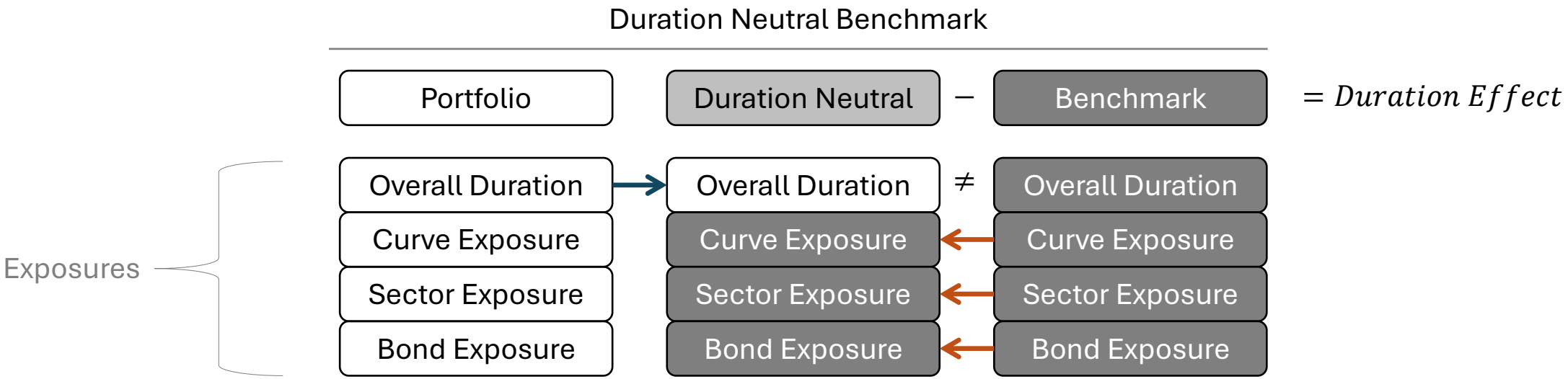
Powered by Robust Technologies -		Base (CAD)			Duration		
Issuer	Issue	Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin	Yield Change
Benchmark BM		**100.00%**	**1.25%**	**1.25%**	**11.61**	**11.61**	**-0.11%**
Total Sector (Short)		**21.36%**	**0.16%**	**0.75%**	**2.29**	**0.49**	**-0.33%**
Canada		8.47%	0.02%	0.20%	1.07	0.09	-0.19%
Corporate		8.46%	0.12%	1.40%	3.50	0.30	-0.40%
Provincial		4.43%	0.02%	0.54%	2.30	0.10	-0.24%
Total Sector (Mid)		**36.92%**	**0.37%**	**0.99%**	**8.00**	**2.95**	**-0.12%**
Canada		21.29%	0.19%	0.90%	8.53	1.82	-0.11%
Corporate		5.73%	0.02%	0.43%	7.87	0.45	-0.05%
Provincial		9.90%	0.15%	1.49%	6.94	0.69	-0.22%
Total Sector (Long)		**41.72%**	**0.73%**	**1.74%**	**19.57**	**8.16**	**-0.09%**
Canada		23.37%	0.28%	1.20%	22.82	5.33	-0.05%
Provincial		18.35%	0.45%	2.43%	15.42	2.83	-0.16%

Exposure

Yield Change

Isolate First Level of Exposure: Duration

- Build a **Duration Neutral** Benchmark
- Make **Benchmark Duration** = **Portfolio**. Leave remaining exposures of Benchmark as is.
- Answers the question: "*What would have been the return of the Benchmark if it had the Duration of the portfolio, but everything else in the benchmark remained the same?*"



Constructing Duration Neutral Benchmarks

		Passive	Active			
	Yield Change	Benchmark	Duration Neutral	Curve Neutral	Sector Neutral	Portfolio
Benchmark BM	-0.11%	11.61	14.97	14.97	14.97	14.97
Total Sector (Short)	-0.33%	0.49	0.63	0.31	0.31	0.31
Canada	-0.19%	0.09	0.12	0.06	0.08	0.08
Corporate	-0.40%	0.30	0.38	0.19	0.13	0.13
Provincial	-0.24%	0.10	0.13	0.06	0.09	0.09
Total Sector (Mid)	-0.12%	2.95	3.81	2.37	2.37	2.37
Canada	-0.11%	1.82	2.34	1.46	0.33	0.33
Corporate	-0.05%	0.45	0.58	0.36	0.81	0.81
Provincial	-0.22%	0.69	0.89	0.55	1.23	1.23
Total Sector (Long)	-0.09%	8.16	10.53	12.30	12.30	12.30
Canada	-0.05%	5.33	6.88	8.03	10.35	10.35
Provincial	-0.16%	2.83	3.65	4.26	1.94	1.94

Constructing of Duration Neutral Benchmark

Making Benchmark Duration = Portfolio everything else (Curve, Sector and Bond) remaining as per Benchmark

Powered by Robust Technologies -		Base (CAD)			Duration	
Issuer	Issue	Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin
Portfolio PF		**100.00%**	**1.29%**	**1.29%**	**14.97**	**14.97**

Powered by Robust Technologies -		Base (CAD)	Duration				0.36%
Issuer	Issue	Time Weighted Return	Duration Begin	Duration Contrib Begin	Yield Change	Duration Neutral	DN Contrib
Benchmark BM		**1.25%**	**11.61**	**11.61**	**-0.11%**	**14.97**	**1.61%**

$$\Delta Y = -\frac{R - rf}{D}$$

Given a **duration** of **11.61** and a **return** of **1.25%** The implied **yield change** of the **benchmark** is **-0.11%**

Given a **yield change** of **-0.11%,** if the **benchmark** had the **duration of the portfolio, 14.97** , it's **return** would have been**1.61%.**

$$R = rf + (-D \times \Delta Y)$$

Therefore, having **a higher duration** in the portfolio **added 0.36%** = (1.61% - 1.29%)

Duration Effect

Issuer	Issue	Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin
Portfolio PF		**100.00%**	**1.29%**	**1.29%**	**14.97**	**14.97**

Issuer	Issue	Weight Begin	TW Contri-bution	Time Weighted Return	Duration Begin	Duration Contrib Begin	Yield Change
Benchmark BM		**100.00%**	**1.25%**	**1.25%**	**11.61**	**11.61**	**-0.11%**

Overexpose

Positive Market

Negative Yield Variation

Good Decision

Positive Duration Effect

Powered by Robust Technologies -

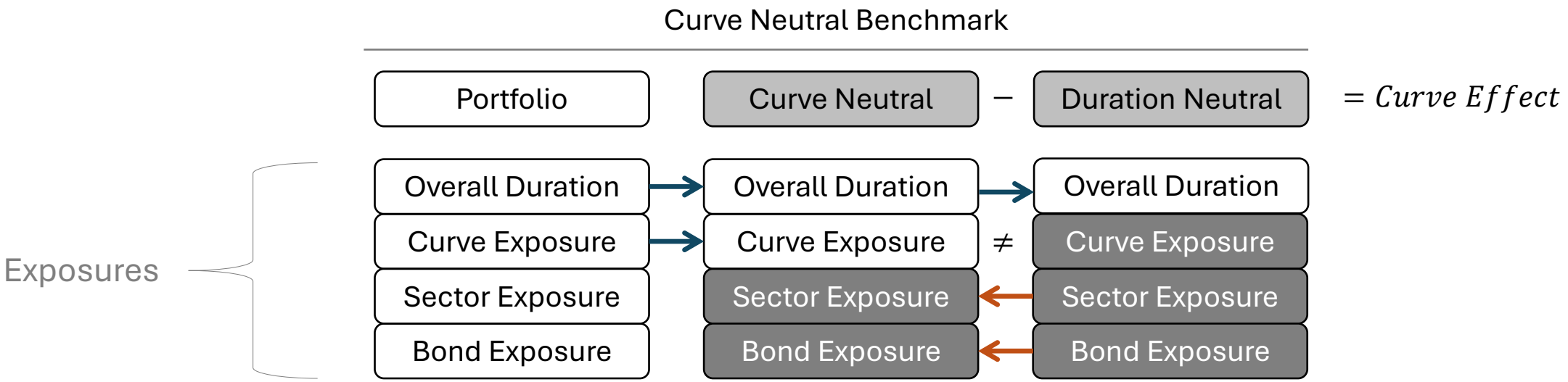
Sec Id	Issuer	Invested First	Invested Last	Portfolio Return	Portfolio Weight	Benchmark Return	Benchmark Weight	Excess Return	Excess Weight	Duration Arith.	Duration $ Earned
Root	**Total Sector**	**1-Jan-19**	**31-Jan-19**	**1.29%**	**100.00%**	**1.25%**	**100.00%**	**0.04%**	**-**	**0.36%**	**95,339**

Arith. Refer.	Arith. Spread
0.24%	**0.12%**

$ Earned Refer.	$ Earned Spread
63,565	**31,774**

Isolate Second Level of Exposure: Yield Curve Positioning

- Build a Curve Neutral Benchmark
- Make Benchmark's partial duration for each maturity buckets = partial durations of portfolio's maturity buckets. Leave remaining exposures of Benchmark as is.
- Answers the question: "What would have been the return of the Benchmark if it had the **Duration** and **Curve** Exposures of the **portfolio**, and the **Sectors** and **Bonds** of the Benchmark?"



Constructing Curve Neutral Benchmarks

	Yield Change	Benchmark	Passive: Duration Neutral	Active: Curve Neutral	Active: Sector Neutral	Portfolio
Benchmark BM	-0.11%	11.61	14.97	14.97	14.97	14.97
Total Sector (Short)	-0.33%	0.49	0.63	0.31	0.31	0.31
Canada	-0.19%	0.09	0.12	0.06	0.08	0.08
Corporate	-0.40%	0.30	0.38	0.19	0.13	0.13
Provincial	-0.24%	0.10	0.13	0.06	0.09	0.09
Total Sector (Mid)	-0.12%	2.95	3.81	2.37	2.37	2.37
Canada	-0.11%	1.82	2.34	1.46	0.33	0.33
Corporate	-0.05%	0.45	0.58	0.36	0.81	0.81
Provincial	-0.22%	0.69	0.89	0.55	1.23	1.23
Total Sector (Long)	-0.09%	8.16	10.53	12.30	12.30	12.30
Canada	-0.05%	5.33	6.88	8.03	10.35	10.35
Provincial	-0.16%	2.83	3.65	4.26	1.94	1.94

Constructing Curve Neutral Benchmark

Making Benchmark **Duration** and **Curve** exposures = to Portfolio, Sector and Bond) remaining as per Benchmark

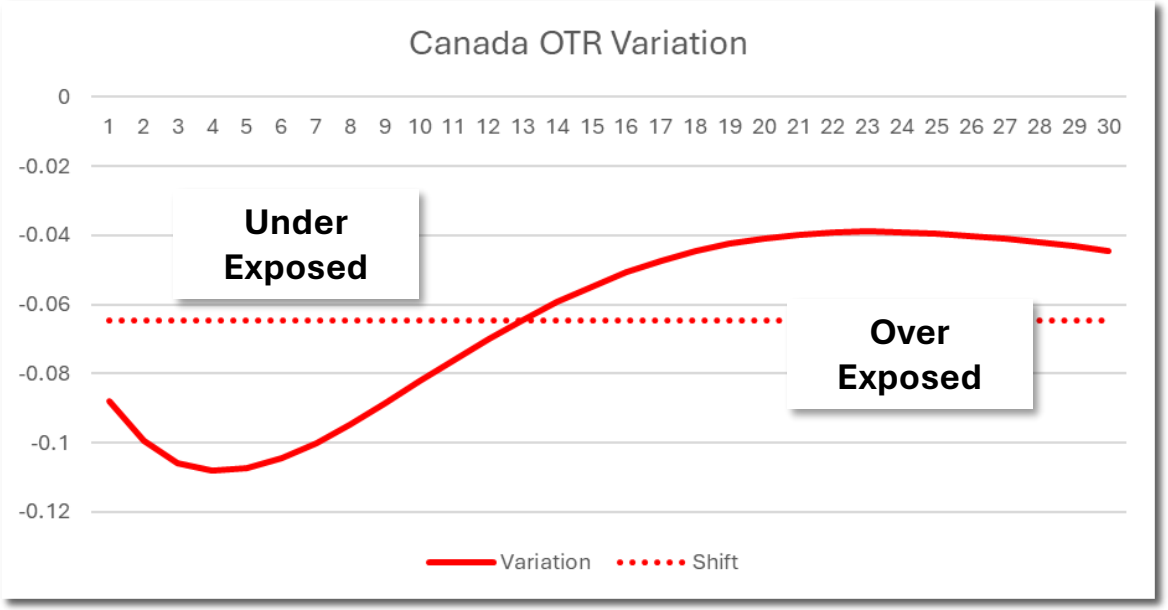
Portfolio	Duration Contrib Begin	Issuer	Yield Change	Passive Duration Neutral	Passive Curve Neutral	Active CN Active Exposure
	14.97	Benchmark BM	-0.11%	14.97	14.97	
	0.31	Total Sector (Short)	-0.33%	0.63	0.31	-0.32
	2.37	Total Sector (Mid)	-0.12%	3.81	2.37	-1.44
	12.30	Total Sector (Long)	-0.09%	10.53	12.30	1.76

→ **Under** exposed yield drop **More**

→ **Under** exposed yield drop **More**

→ **Over** exposed yield drop **Less**

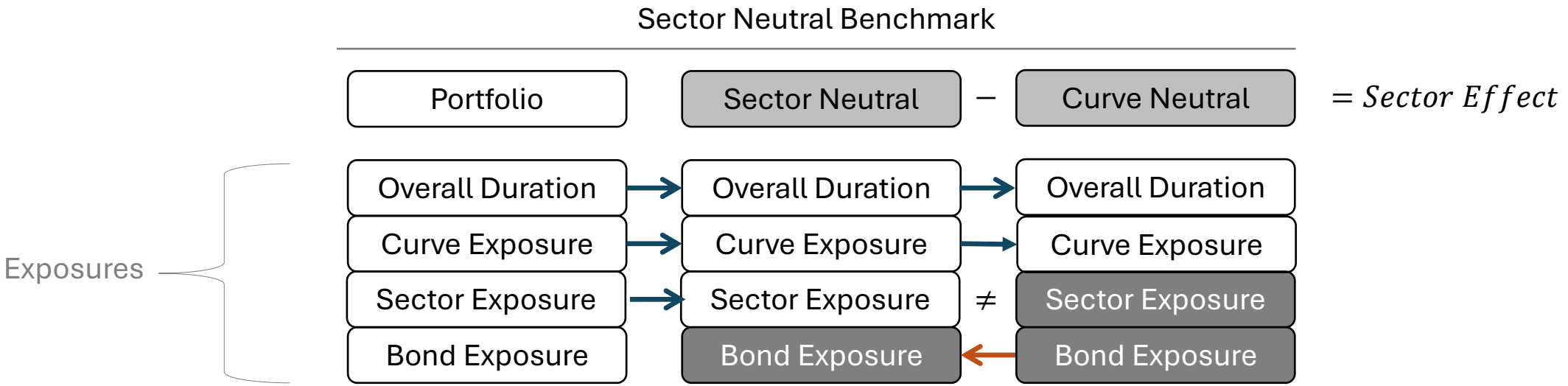
	Curve Arith.	Curve $ Earned
Detract value	**-0.13%**	**-33,365**
	-0.07%	-18,657
	-0.02%	-5,983
	-0.03%	-8,725



Issuer	Arith. Refer.	$ Earned Refer.	Arith. Spread	$ Earned Spread
Total	**-0.12%**	**-31,477**	**-0.01%**	**-1,888**
Short	-0.03%	-6,603	-0.05%	-12,054
Mid	0.00%	656	-0.03%	-6,638
Long	-0.10%	-25,529	0.06%	16,804

Isolate Third Level of Exposure: Sector / Credit Allocation

- Build a **Sector Neutral** Benchmark
- Answers the question: "*What would have been the return of the Benchmark if it had the duration, the yield curve exposures and the sector allocations of the portfolio but keeping the bonds of the Benchmark?*"



Constructing Sector Neutral Benchmarks

	Yield Change	Benchmark	Duration Neutral	Curve Neutral	Sector Neutral	Portfolio
				Passive	Active	
Benchmark BM	-0.11%	11.61	14.97	14.97 →	14.97	14.97
Total Sector (Short)	-0.33%	0.49	0.63	0.31 →	0.31	0.31
Canada	-0.19%	0.09	0.12	0.06 →	0.08 ←	0.08
Corporate	-0.40%	0.30	0.38	0.19 →	0.13 ←	0.13
Provincial	-0.24%	0.10	0.13	0.06 →	0.09 ←	0.09
Total Sector (Mid)	-0.12%	2.95	3.81	2.37 →	2.37	2.37
Canada	-0.11%	1.82	2.34	1.46 →	0.33 ←	0.33
Corporate	-0.05%	0.45	0.58	0.36 →	0.81 ←	0.81
Provincial	-0.22%	0.69	0.89	0.55 →	1.23 ←	1.23
Total Sector (Long)	-0.09%	8.16	10.53	12.30 →	12.30	12.30
Canada	-0.05%	5.33	6.88	8.03 →	10.35 ←	10.35
Provincial	-0.16%	2.83	3.65	4.26 →	1.94 ←	1.94

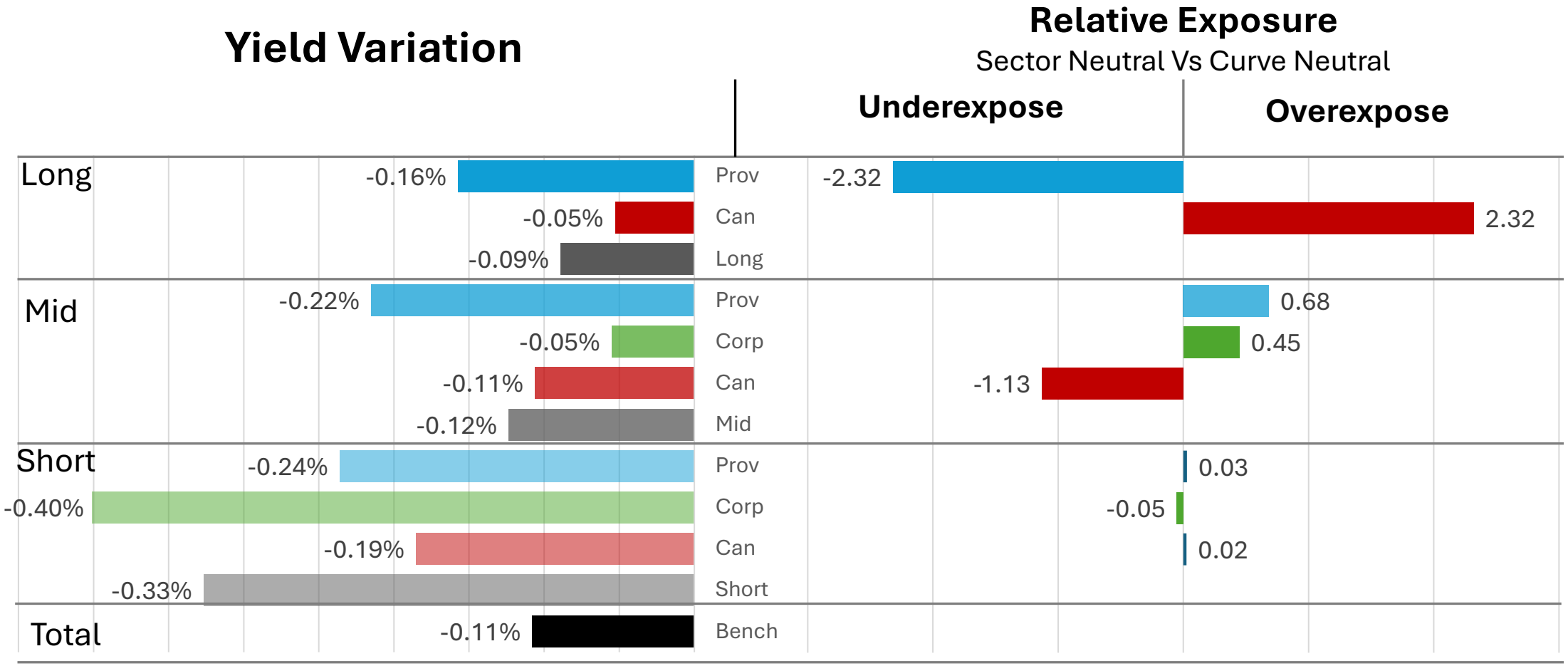
Constructing Curve Sector Benchmark

Making Benchmark **Duration, Curve** and **Sector** exposures = to Portfolio, and Bonds remaining as per Benchmark

Portfolio

Powered by Robust Technologies

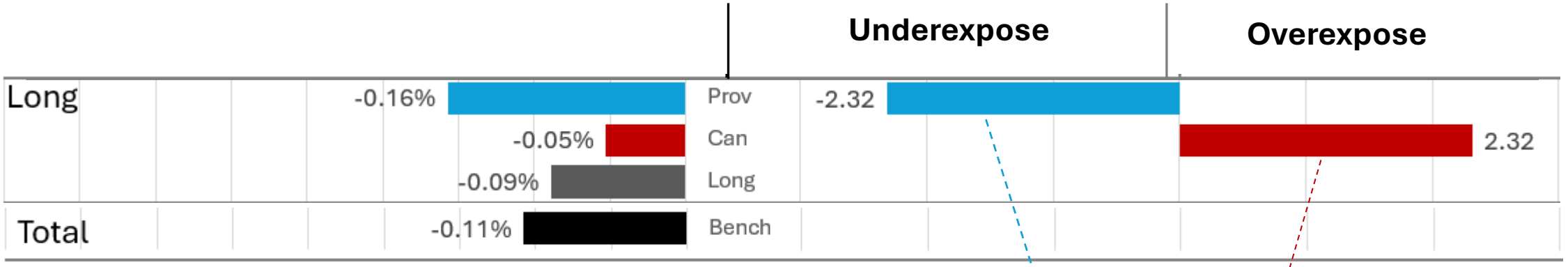
Issuer	Duration Contrib Begin	Issuer	Yield Change	Curve Neutral	Sector Neutral	SN Active Exposure		Sector Arith.	Sector Geo.	Sector $ Earned
Portfolio PF	**14.97**	**Benchmark BM**	**-0.11%**	**14.97**	**14.97**			**-0.20%**	**-0.20%**	**-52,762**
Total Sector (Short)	**0.31**	**Total Sector (Short)**	**-0.33%**	**0.31**	**0.31**			**-0.01%**	**-0.01%**	**(2,601)**
Canada	0.08	Canada	-0.19%	0.06	0.08	0.02		0.00%	0.00%	557
Corporate	0.13	Corporate	-0.40%	0.19	0.13	-0.05		-0.02%	-0.02%	(4,154)
Provincial	0.09	Provincial	-0.24%	0.06	0.09	0.03		0.00%	0.00%	997
Total Sector (Mid)	**2.37**	**Total Sector (Mid)**	**-0.12%**	**2.37**	**2.37**			**0.05%**	**0.05%**	**13,537**
Canada	0.33	Canada	-0.11%	1.46	0.33	-1.13		-0.01%	-0.01%	(2,005)
Corporate	0.81	Corporate	-0.05%	0.36	0.81	0.45		-0.02%	-0.02%	(5,222)
Provincial	1.23	Provincial	-0.22%	0.55	1.23	0.68	→ **Over** drop **More** →	0.08%	0.08%	20,764
Total Sector (Long)	**12.30**	**Total Sector (Long)**	**-0.09%**	**12.30**	**12.30**			**-0.24%**	**-0.24%**	**(63,698)**
Canada	10.35	Canada	-0.05%	8.03	10.35	2.32	→ **Over** drop **Less** →	-0.11%	-0.11%	(28,379)
Provincial	1.94	Provincial	-0.16%	4.26	1.94	-2.32	→ **Under** drop **More** →	-0.13%	-0.13%	(35,319)


Yield Variation
Relative Exposure
Sector Neutral Vs Curve Neutral
Underexpose
Overexpose
Long
-0.16%
Prov
-2.32
-0.05%
Can
2.32
-0.09%
Long
Mid
-0.22%
Prov
0.68
-0.05%
Corp
0.45
-0.11%
Can
-1.13
-0.12%
Mid
Short
-0.24%
Prov
0.03
-0.40%
Corp
-0.05
-0.19%
Can
0.02
-0.33%
Short
Total
-0.11%
Bench

Yield Variation

Relative Exposure

Sector Neutral Vs Curve Neutral



Portfolio

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Issuer	Duration	Duration Contrib Begin	Issuer	Yield Change	Curve Neutral	Sector Neutral	SN Active Exposure		Sector Arith.	Sector Geo.	Sector $ Earned
Total Sector (Long)		**12.30**	**Total Sector (Long)**	**-0.09%**	**12.30**	**12.30**			**-0.24%**	**-0.24%**	**(63,698)**
Canada		**10.35**	**Canada**	**-0.05%**	**8.03**	**10.35**	**2.32**	→ Over drop Less →	-0.11%	-0.11%	(28,379)
Provincial		**1.94**	**Provincial**	**-0.16%**	**4.26**	**1.94**	**-2.32**	→ Under drop More →	-0.13%	-0.13%	(35,319)

Exposure Decomposition Approach

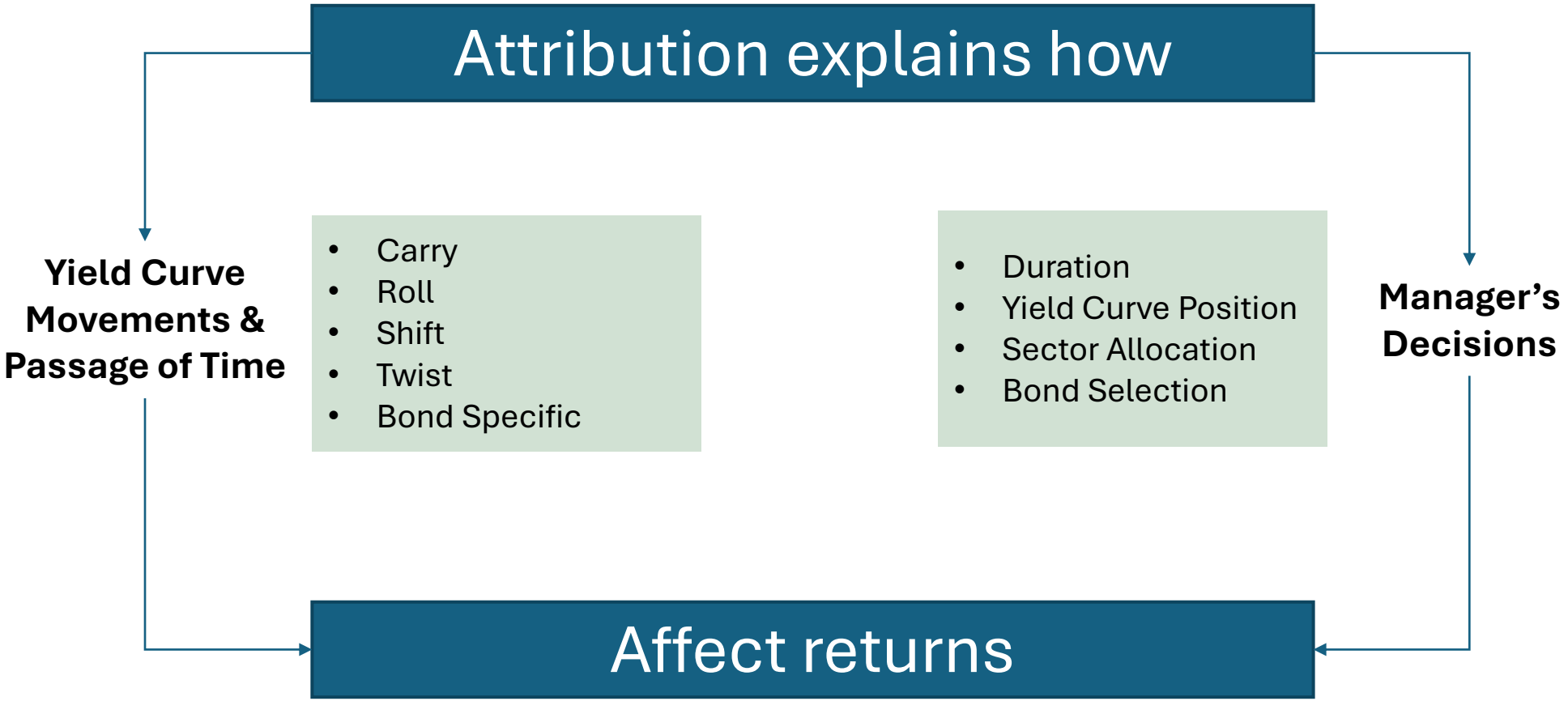
Portfolio PF vs Benchmark BM
2019-01-01 to 2019-01-31
Exposure Decomposition

Powered by Robust Technologies -

	Portfolio				Benchmark				Excess			Duration		Curve		Sector Allocation		Selection		Total	
Issuer	Return	Weight	Begin Duration	Begin Duration Contribution	Return	Weight	Begin Duration	Begin Duration Contribution	Return	Begin Duration	Begin Duration Contribution	Arith.	$ Earned	Arith.	$ Earned	Arith.	$ Earned	Arith.	$ Earned	Arith.	$ Earned
Total Sector	**1.29%**	**100.00%**	**14.97**	**14.97**	**1.25%**	**100.00%**	**11.61**	**11.61**	**0.04%**	**3.37**	**3.37**	**0.36%**	**95,339**	**-0.13%**	**-33,365**	**-0.20%**	**-52,762**	**0.01%**	**1,452**	**0.04%**	**10,664**
Short	0.59%	15.39%	1.99	0.31	0.75%	21.36%	2.29	0.49	-0.16%	-0.30	-0.18	0.05%	12,166	-0.07%	-18,657	-0.01%	-2,601	-	-	-0.03%	-9,091
Canada	0.20%	7.61%	1.07	0.08	0.20%	8.47%	1.07	0.09	-	-	-0.01	0.00%	1,279	-0.00%	-1,224	0.00%	557	-	-	0.00%	612
Corporate	1.40%	3.80%	3.50	0.13	1.40%	8.46%	3.50	0.30	-	-	-0.16	0.03%	9,054	-0.06%	-15,153	-0.02%	-4,154	-	-	-0.04%	-10,253
Provincial	0.54%	3.98%	2.30	0.09	0.54%	4.43%	2.30	0.10	-	-	-0.01	0.01%	1,833	-0.01%	-2,280	0.00%	997	-	-	0.00%	550
Mid	1.08%	31.90%	7.43	2.37	0.99%	36.92%	8.00	2.95	0.09%	-0.57	-0.58	0.11%	27,823	-0.02%	-5,983	0.05%	13,537	-	-	0.13%	35,377
Canada	0.90%	3.82%	8.53	0.33	0.90%	21.29%	8.53	1.82	-	-	-1.49	0.06%	14,675	0.00%	403	-0.01%	-2,005	-	-	0.05%	13,073
Corporate	0.43%	10.30%	7.87	0.81	0.43%	5.73%	7.87	0.45	-	-	0.36	0.01%	1,890	0.01%	3,051	-0.02%	-5,222	-	-	-0.00%	-281
Provincial	1.49%	17.78%	6.94	1.23	1.49%	9.90%	6.94	0.69	-	-	0.55	0.04%	11,257	-0.04%	-9,437	0.08%	20,764	-	-	0.09%	22,585
Long	1.63%	52.71%	23.33	12.30	1.74%	41.72%	19.57	8.16	-0.11%	3.76	4.13	0.21%	55,350	-0.03%	-8,725	-0.24%	-63,698	0.01%	1,452	-0.06%	-15,621
Canada	1.35%	40.86%	25.34	10.35	1.20%	23.37%	22.82	5.33	0.15%	2.51	5.02	0.08%	21,425	-0.06%	-16,679	-0.11%	-28,379	0.01%	1,919	-0.08%	-21,714
Provincial	2.57%	11.84%	16.42	1.94	2.43%	18.35%	15.42	2.83	0.14%	0.99	-0.89	0.13%	33,925	0.03%	7,955	-0.13%	-35,319	-0.00%	-468	0.02%	6,093

Two different tools

Two different measures



Different Tools for Measures of Healthy Weight

Body Mass Index (BMI)

Body Fat Index

Different Tools for Different Audience

Portfolio Managers

Yield Curve Decomposition

Describe added value in terms that a portfolio manager can understand, i.e.:

- **Yield Curve Movements**

Clients, Board

Exposure Decomposition

Describe added value in terms that board of directors and clients understand better, i.e:

- **Investment Decisions**

Introduction to Fixed-Income Attribution

by Claude Giguère, BScA, and Andrew Kophamel, FRM, CFA, CIPM

Claude Giguère, BScA, is at Robust Technologies Inc. (Canada). Andrew Kophamel, FRM, CFA, CIPM (Australia).

LEARNING OUTCOMES

Mastery	The candidate should be able to:
☐	a. describe the three major approaches to fixed-income attribution (exposure decomposition—duration based, yield curve decomposition—duration based, and yield curve decomposition—full repricing);
☐	b. compare the three major approaches to fixed-income attribution in terms of associated decision-making processes, typical users, operational considerations, and limitations;
☐	c. describe and evaluate the three major approaches to fixed-income attribution in terms of their implementation, output, interpretation, and appropriate applications by various users;
☐	d. analyze and interpret the output of a fixed-income attribution analysis.

INTRODUCTION 1

Performance attribution is a tool that allows a performance analyst to explain the sources of any value added or subtracted by active management of a portfolio in relation to its benchmark. Returns are decomposed into terms that are commonly called attribution effects.

To be useful, performance attribution must abide by certain rules. First and foremost, the benchmark must be representative of the investment management mandate, objective, and constraints. Second, the calculation must be performed frequently enough to effectively capture the active decisions of the manager. Third, the attribution methodology must produce attribution effects that can be related directly to the investment management decisions made by the manager. If any of these criteria are not met, the fundamental purpose of attribution analysis will not be served.

The process of managing portfolios can be quite complex and differs substantially depending on the type of the investments: Domestic versus global, equity versus fixed income, cash versus derivative instruments, and long-only versus long–short hedge fund strategies will all be managed differently, and the investment decision-making process will differ for each. For example, equity managers try to predict outperforming

Question and Discussion

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