Last Revised: 04/23/2025

2026 Level 3 - Performance Measurement

Portfolio Performance Evaluation

a. explain the following components of portfolio evaluation and their interrelationships: performance measurement, performance attribution, and performance appraisal

b. describe attributes of an effective attribution process

c. contrast return attribution and risk attribution; contrast macro and micro return attribution

d. describe returns-based, holdings-based, and transactions-based performance attribution, including advantages and disadvantages of each

e. interpret the sources of portfolio returns using a specified attribution approach

f. interpret the output from fixed-income attribution analyses

g. discuss considerations in selecting a risk attribution approach

h. identify and interpret investment results attributable to the asset owner versus those attributable to the investment manager

i. discuss uses of liability-based benchmarks

j. describe types of asset-based benchmarks

k. discuss tests of benchmark quality

l. describe problems that arise in benchmarking alternative investments

m. describe the impact of benchmark misspecification on attribution and appraisal analysis

n. calculate and interpret the Sortino ratio, the appraisal ratio, upside/downside capture ratios, maximum drawdown, and drawdown duration

o. describe limitations of appraisal measures and related metrics

p. evaluate the skill of an investment manager

Portfolio Performance Evaluation

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- explain

⇒ Performance

a) measurement (typically relative to a benchmark)

- absolute return → what the portfolio achieved over a specific period
- excess return → portfolio return - benchmark return
- also involves measuring the risk incurred to achieve that return

b) attribution - how that performance was achieved or how the risk was incurred

- explain absolute or relative return
- what portion was driven by active mgr. decisions
- decompose excess return into component sources
- decompose risk

c) evaluation - draw conclusions regarding the quality of performance
- distinguish manager luck from skill

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- an effective process must
  1) account for all the portfolio's return or risk exposure
  2) reflect the investment decision-making process
  3) quantify the active decisions of the PM
  4) provide a complete understanding of the excess return/risk of the portfolio

LOS c
- distinguish

- Return attribution - analyzes the impact of active investment decisions on returns
- Risk attribution - analyzes the risk consequences of those (absolute or benchmark relative terms) decisions
- Micro attribution - understanding the drivers of a manager's returns and whether those drivers are consistent with the stated investment process

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- Macro attribution - measures the effect of the asset owner's (sponsor's) choice to deviate from the SAA
  - also measures the effect of the manager selection and timing decisions

LOS d
- describe

- Returns-based attribution
  - uses only total portfolio return
  - most appropriate when underlying portfolio information is not available at the requires frequency or detail
  - easiest to implement
  - least accurate
  - vulnerable to data manipulation

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- Holdings-based attribution
  - use actual holdings (beginning of period)
  - all transactions are assumed to occur at end of day
  - accuracy improves when data has shorter time intervals
  - most appropriate for investment strategies with little turnover
- transactions-based attribution
  - uses both the holdings and the transactions during the evaluation period
  - most accurate, but most difficult and time consuming to implement

- choice of approach depends on the availability and quality of the underlying data

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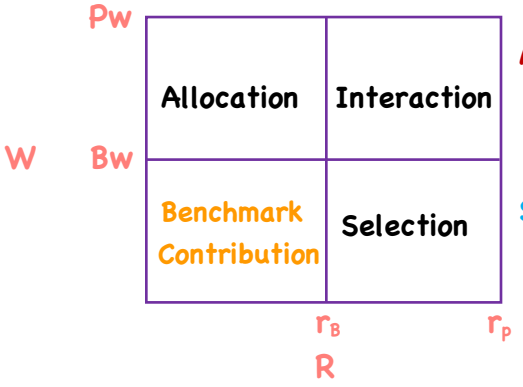
→ Approaches/ - specific approaches have been designed to evaluate specific types of assets

• Equity attribution/

1/ Brinson-Hood-Beebower (BHB) — Brinson-Fachler (BF)



Allocation = $(Pw - Bw) \times r_B$ → only this → Allocation = $(Pw - Bw)(r_B - R_B)$

Selection = $(r_P - r_B) \times Bw$

Interaction = $(Pw - Bw)(r_P - r_B)$

} = $(r_P - r_B) \times Pw$

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• Equity attribution/

1/ Brinson-Hood-Beebower — Brinson-Fachler

Rewards: overw. when $r_s > 0$, underw. when $r_s < 0$ — Rewards: overw. when $r_s > R_B$, underw. when $r_s < R_B$

e.g./ $w_P = 8\%$ $w_B = 4\%$ $r_B = -3\%$ $R_B = -9\%$

Allocation = $(W_P - W_B) \times r_B$
= $(.08 - .04) \times -.03$
= $-.0012$
(penalizes)

Allocation = $(.08 - .04)(-.03 - (-.09))$
= $.04 \times .06$
= $.0024$
(rewards)

BHB views allocation from an absolute positive or negative perspective

BF views allocation from a relative perspective versus total benchmark return

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• Equity attribution/

1/ Brinson-Hood-Beebower — Brinson-Fachler

Sector	Portfolio Weight	Benchmark Weight	Portfolio Return	Benchmark Return
Energy	50%	50%	18%	10%
Health care	30%	20%	−3%	−2%
Financials	20%	30%	10%	12%
Total	**100%**	**100%**	**10.1%**	**8.2%**

$R_A = 1.9\%$

Allocation: $(P_w - B_w) \times r_B$ = $(P_w - B_w)(r_B - R_B)$

Energy: (.5 - .5) x .10 = 0% — (.5 - .5)(.10 - .082) = 0%

HC: (.3 - .2) x -.02 = -.2% — (.3 - .2)(-.02 - .082) = -.0102

Fin: (.2 - .3) x .12 = -1.2% — (.2 - .3)(.12 - .082) = -.0038

-1.4% — -1.4%

Security: $(r_p - r_B) \times B_w$ — **Interaction:** $(r_p - r_B)(w_p - w_B)$

Energy: (.18 - .10) x .5 = 4% — (.18 - .10)(.5 - .5) = 0%

HC: (-.03 - (-.02)) x .2 = -.2% — (-.03 - (-.02))(.3 - .2) = -.1%

Fin: (.1 - .12) x .3 = -.6% — 3.2% — (.1 - .12)(.2 - .3) = .2% — .1%

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• Equity attribution/

2/ Factor-based - fundamental factor models

- decompose contributions to excess returns from factors

$$R_p - R_f = \alpha + b_1 RMRF + b_2 SMB + b_3 HML + b_4 WML + \varepsilon_p$$

(Carhart 4-factor model)

market | size | value | momentum

(< 0 = Lg. Cap.) (> 0 = value)

e.g./

	Factor Sensitivity				Contribution to Active Return	
	Portfolio	Benchmark	Difference	Factor Return	Absolute	Proportion of Total
Factor	**(1)**	**(2)**	**(3)**	**(4)**	**(3) × (4)**	**Active**
RMRF	0.95	1.00	−0.05	5.52%	−0.28%	−13.30%
SMB	−1.05	−1.00	−0.05	−3.35%	0.17%	8.10%
HML	0.40	0.00	0.40	5.10%	2.04%	98.40%
WML	0.05	0.03	0.02	9.63%	0.19%	9.30%
				A. Factor tilts return =	2.12%	102.40%
				B. Security selection =	−0.05%	−2.40%
				C. Active return (A + B) =	2.07%	100.00%

Benchmark

RMRF = 1 = broad-based market index

SMB = -1 = large-cap. index

HML = 0 → no value/growth bias

portfolio → large-cap. value

(ex. #4)

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• Fixed Income Attribution

1/ Exposure decomposition - top-down approach

Benchmark → Duration
→ yield curve positioning
→ sectors (i.e. gov't., corporate)

vs. Portfolio
- active decisions to deviate from benchmark exposures

e.g./ active duration bets → increase duration relative to benchmark in anticipation of falling rates

yield curve positioning → barbell for a flattening curve

sectors → overweight credits in anticipation of spreads narrowing

• how well, relative to the benchmark, did these active decisions work out, what contribution to active return

- used primarily for client reports, easy to understand

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	Portfolio Weights				Portfolio Duration				Portfolio Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	4.42	7.47	10.21	8.08	0.44	0.75	2.04	3.23
Corporate	10.00%	20.00%	30.00%	60.00%	4.40	7.40	10.06	8.23	0.44	1.48	3.02	4.94
Total	20.00%	30.00%	50.00%	100.00%	4.41	7.42	10.12	8.17	0.88	2.23	5.06	8.17

	Benchmark Weights				Benchmark Duration				Benchmark Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	4.42	7.47	10.21	7.11	0.88	1.49	1.53	3.91
Corporate	15.00%	15.00%	15.00%	45.00%	4.40	7.40	10.06	7.29	0.66	1.11	1.51	3.28
Total	35.00%	35.00%	30.00%	100.00%	4.41	7.44	10.14	7.19	1.54	2.60	3.04	7.19

	Portfolio Weights				Portfolio Returns				Portfolio Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	−3.48%	−5.16%	−4.38%	−4.35%	−0.35%	−0.52%	−0.88%	−1.74%
Corporate	10.00%	20.00%	30.00%	60.00%	−4.33%	−6.14%	−5.42%	−5.48%	−0.43%	−1.23%	−1.63%	−3.29%
Total	20.00%	30.00%	50.00%	100.00%	−3.91%	−5.81%	−5.00%	−5.03%	−0.78%	−1.74%	−2.50%	−5.03%

	Benchmark Weights				Benchmark Returns				Benchmark Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	−3.48%	−5.16%	−4.38%	−4.34%	−0.70%	−1.03%	−0.66%	−2.39%
Corporate	15.00%	15.00%	15.00%	45.00%	−4.33%	−6.14%	−5.86%	−5.44%	−0.65%	−0.92%	−0.88%	−2.45%
Total	35.00%	35.00%	30.00%	100.00%	−3.84%	−5.58%	−5.12%	−4.83%	−1.35%	−1.95%	−1.54%	−4.83%

25% × 4.42
+ 25% × 7.47
+ 50% × 10.21
= 8.08

× 40% weight
= 3.23

vs.

3.91 for the benchmark

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	Portfolio Weights				Portfolio Duration				Portfolio Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	4.42	7.47	10.21	8.08	0.44	0.75	2.04	3.23
Corporate	10.00%	20.00%	30.00%	60.00%	4.40	7.40	10.06	8.23	0.44	1.48	3.02	4.94
Total	20.00%	30.00%	50.00%	100.00%	4.41	7.42	10.12	8.17	0.88	2.23	5.06	8.17

$\frac{3.48\%}{4.42} = .78$

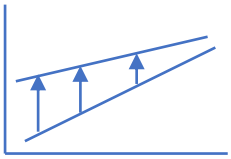
	Benchmark Weights				Benchmark Duration				Benchmark Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	4.42	7.47	10.21	7.11	0.88	1.49	1.53	3.91
Corporate	15.00%	15.00%	15.00%	45.00%	4.40	7.40	10.06	7.29	0.66	1.11	1.51	3.28
Total	35.00%	35.00%	30.00%	100.00%	4.41	7.44	10.14	7.19	1.54	2.60	3.04	7.19

$\frac{4.33\%}{4.40} = .98$

S	M	L	
78	69.5	42.9	G
98	82.9	58.2	C

	Portfolio Weights				Portfolio Returns				Portfolio Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	−3.48%	−5.16%	−4.38%	−4.35%	−0.35%	−0.52%	−0.88%	−1.74%
Corporate	10.00%	20.00%	30.00%	60.00%	−4.33%	−6.14%	−5.42%	−5.48%	−0.43%	−1.23%	−1.63%	−3.29%
Total	20.00%	30.00%	50.00%	100.00%	−3.91%	−5.81%	−5.00%	−5.03%	−0.78%	−1.74%	−2.50%	−5.03%

	Benchmark Weights				Benchmark Returns				Benchmark Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	−3.48%	−5.16%	−4.38%	−4.34%	−0.70%	−1.03%	−0.66%	−2.39%
Corporate	15.00%	15.00%	15.00%	45.00%	−4.33%	−6.14%	−5.86%	−5.44%	−0.65%	−0.92%	−0.88%	−2.45%
Total	35.00%	35.00%	30.00%	100.00%	−3.84%	−5.58%	−5.12%	−4.83%	−1.35%	−1.95%	−1.54%	−4.83%



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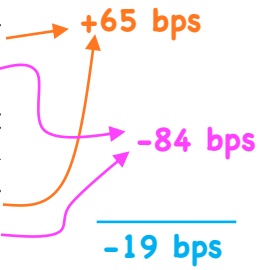
	Portfolio Weights				Portfolio Duration				Portfolio Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	4.42	7.47	10.21	8.08	0.44	0.75	2.04	3.23
Corporate	10.00%	20.00%	30.00%	60.00%	4.40	7.40	10.06	8.23	0.44	1.48	3.02	4.94
Total	20.00%	30.00%	50.00%	100.00%	4.41	7.42	10.12	8.17	0.88	2.23	5.06	8.17

	Benchmark Weights				Benchmark Duration				Benchmark Contribution to Duration			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	4.42	7.47	10.21	7.11	0.88	1.49	1.53	3.91
Corporate	15.00%	15.00%	15.00%	45.00%	4.40	7.40	10.06	7.29	0.66	1.11	1.51	3.28
Total	35.00%	35.00%	30.00%	100.00%	4.41	7.44	10.14	7.19	1.54	2.60	3.04	7.19

$R_p - R_B =$
-5.03% - (-4.83%)
= -.20%

	Portfolio Weights				Portfolio Returns				Portfolio Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	10.00%	10.00%	20.00%	40.00%	−3.48%	−5.16%	−4.38%	−4.35%	−0.35%	−0.52%	−0.88%	−1.74%
Corporate	10.00%	20.00%	30.00%	60.00%	−4.33%	−6.14%	−5.42%	−5.48%	−0.43%	−1.23%	−1.63%	−3.29%
Total	20.00%	30.00%	50.00%	100.00%	−3.91%	−5.81%	−5.00%	−5.03%	−0.78%	−1.74%	−2.50%	−5.03%

	Benchmark Weights				Benchmark Returns				Benchmark Contribution to Return			
	Short	Mid	Long	Total	Short	Mid	Long	Total	Short	Mid	Long	Total
Government	20.00%	20.00%	15.00%	55.00%	−3.48%	−5.16%	−4.38%	−4.34%	−0.70%	−1.03%	−0.66%	−2.39%
Corporate	15.00%	15.00%	15.00%	45.00%	−4.33%	−6.14%	−5.86%	−5.44%	−0.65%	−0.92%	−0.88%	−2.45%
Total	35.00%	35.00%	30.00%	100.00%	−3.84%	−5.58%	−5.12%	−4.83%	−1.35%	−1.95%	−1.54%	−4.83%



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Duration Bucket	Sector	Duration Effect	Curve Effect	Total Interest Rate Allocation	Sector Allocation	Bond Selection	Total
Short	Government					0.00%	0.00%
	Corporate				0.04%	0.00%	0.04%
	Total	*0.40%*	*0.12%*	*0.52%*	*0.04%*	*0.00%*	***0.56%***
Mid	Government					0.00%	0.00%
	Corporate				−0.05%	0.00%	−0.05%
	Total	*0.23%*	*0.03%*	*0.26%*	*−0.05%*	*0.00%*	***0.21%***
Long	Government					0.00%	0.00%
	Corporate				−0.22%	0.13%	−0.09%
	Total	*−1.25%*	*0.37%*	*−0.88%*	*−0.22%*	*0.13%*	***−0.97%***
Total		**−0.62%**	**0.52%**	**−0.10%**	**−0.23%**	**0.13%**	**−0.20%**

total underperformance

D_P vs. D_B

where along the curve the difference in duration comes from

level
slope
curvature

B_w in Gov't./Credits vs. P_w (-/+)

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• Fixed Income Attribution

2/ Yield curve decomposition - duration based

- can be either top-down or bottom-up

→ estimates the returns based on duration

%total return = %Income return + %Price change

-ModDur × Δyield

- applied to both the portfolio and the benchmark
  - difference = effect of active PM decisions

- requires more data points than exposure decomp.
- typically used in reports for analysts & PMs

3/ Yield curve decomposition - full repricing - instead of using estimates

- prices out each security
- most complex attribution of the three

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Bond	Yield	Roll	Shift	Slope	Curvature	Spread	Specific	Residual	Total
Gov't. 5% 30 June 21	–0.19%	–0.04%	0.43%	0.01%	0.15%	0.00%	0.00%	–0.01%	0.35%
Gov't. 7% 30 June 26	–0.22%	–0.03%	0.71%	0.04%	0.04%	0.00%	0.00%	–0.03%	0.52%
Gov't. 6% 30 June 31	0.12%	0.01%	–0.48%	0.05%	0.09%	0.00%	0.00%	–0.01%	–0.22%
Corp. 5% 30 June 21	–0.11%	–0.02%	0.21%	0.05%	0.05%	0.04%	0.02%	–0.02%	0.22%
Corp. 7% 30 June 26	0.12%	0.01%	–0.35%	–0.02%	–0.02%	–0.07%	0.00%	0.02%	–0.31%
Corp. (B) 6% 30 June 31	–0.39%	–0.03%	1.41%	–0.26%	–0.11%	0.30%	0.00%	–0.04%	0.88%
Corp. (P) 6% 30 June 31	0.78%	0.06%	–2.82%	0.52%	0.33%	–0.60%	0.15%	–0.05%	–1.63%
Total	0.11%	–0.04%	–0.89%	0.39%	0.53%	–0.33%	0.17%	–0.14%	–0.20%
	Time:	*0.08%*	*Curve Movement:*		*0.03%*				

positive → yield, slope, curve } overweight long bonds

specific → bond selection

example #5

negative roll → overw. long bonds

shift → $D_P > D_B$

spread → overweight credits

residual → duration is only an

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- discuss

→ Risk Attribution/
- absolute mandates → identifies sources of volatility
- benchmark relative → identifies the sources of tracking risk

Investment Decision-Making Process	Relative	Absolute
Bottom up	- position's marginal contribution to tracking risk	- position's marginal contribution to total risk
Top Down	- attribute tracking risk to relative allocation and selection decision	
Factor-based	- factor's marginal contribution to tracking risk and active specific risk	- factor's marginal contribution to total risk and specific risk (example #6)