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Principles of Performance Attribution

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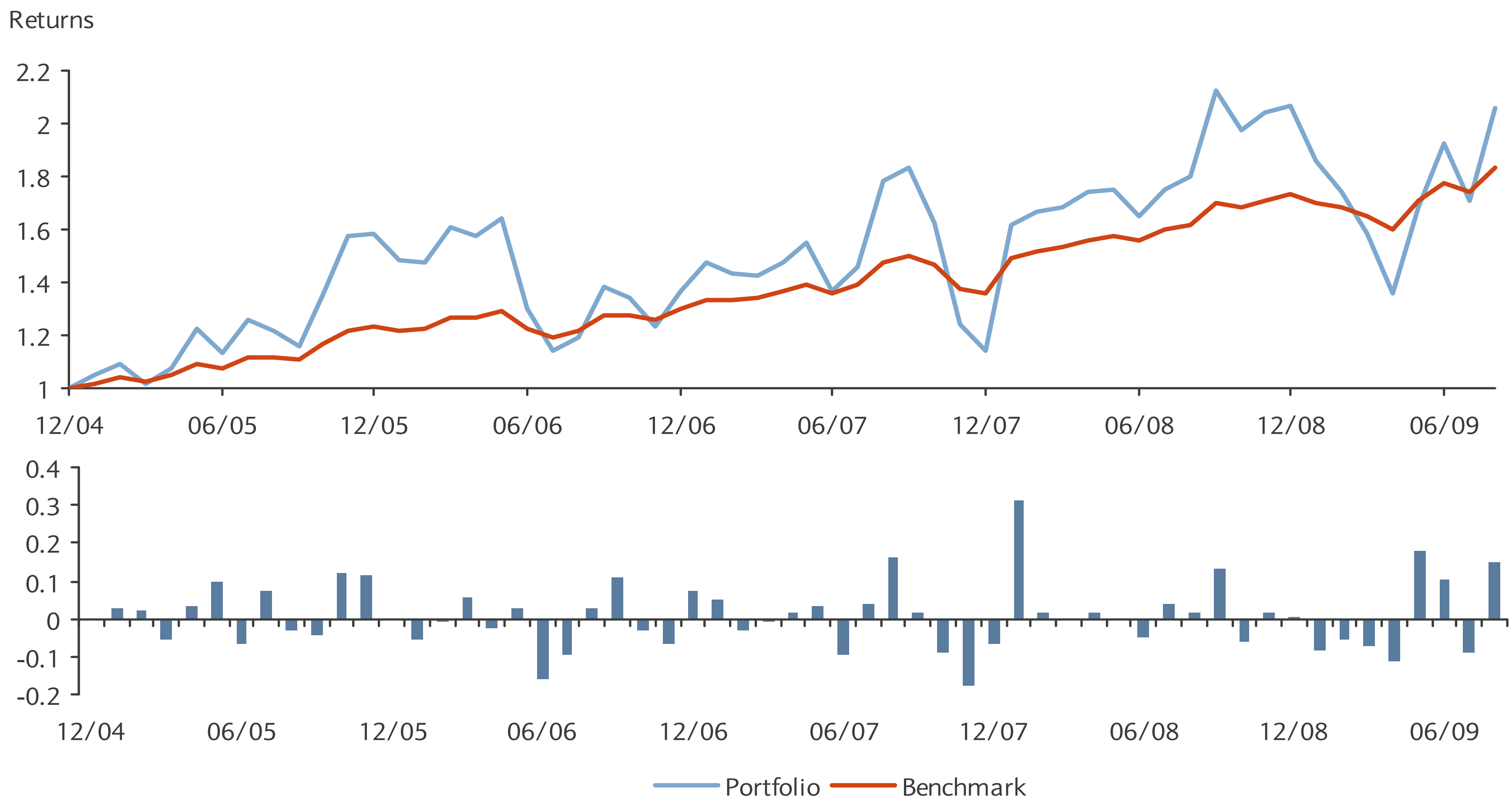
Agenda

- Introduction
- Sector-based attribution
  - Asset allocation / security selection
  - Hurdle rate
  - Interaction
  - Multi-level attribution
- Factor-based attribution
  - Attribution to risk factors
- Hybrid performance attribution
  - Excess return attribution
- Extensions
  - Risk measure as allocation weights
  - Capturing outperformance from market timing
- Conclusion

What Is Performance Attribution?

- Attribute outperformance to appropriate decisions / exposures



Source: Barclays Capital.

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Challenges

- Complexity of portfolio management structure
- Example: global fixed income / equity mixed portfolio
- Allocation decisions
  - Global allocation to different local markets
  - Exposure to different asset classes: equity and within fixed income
  - Local allocation to sectors
  - Selection of securities within each sector
- Risk exposure management
  - FX
  - Market
  - Interest rate
  - Volatility
- Performance attribution must reflect decision-making process

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Two Methodologies of Attribution

Two Methodologies

Sector-based attribution – the Brinson model

- Widely used for equity
- Outperformance explained by asset allocation and security selection
- Asset allocation: active weighting of sectors
- Security selection: active returns of sectors

Factor-based attribution

- Widely used for fixed income
- Outperformance explained by active exposure to “risk” factors
- Security returns decomposed into contributing factors
- Security selection is derived from idiosyncratic return

Sector-Based Attribution

- Return as weighted sum of sector returns

$$R^P = \sum_s w_s^P R_s^P , \qquad R^B = \sum_s w_s^B R_s^B$$

- Outperformance decomposition (top-down) [absolute allocation]

$$R^P - R^B = \sum_s w_s^P R_s^P - \sum_s w_s^B R_s^B$$

$$= \underbrace{\sum_s \left(w_s^P - w_s^B\right) \cdot \left(R_s^B - R^B\right)}_{\text{Asset Allocation}} + \underbrace{\sum_s w_s^B \cdot \left(R_s^P - R_s^B\right)}_{\text{Security Selection}} + \underbrace{\sum_s \left(w_s^P - w_s^B\right) \cdot \left(R_s^P - R_s^B\right)}_{\text{Interaction}}$$

- Asset allocation: positive if overweight sector that outperforms overall benchmark
- Security selection: positive if securities selected within sector yield higher sector return than benchmark sector return
- Interaction: cross product of over / underweight and out / underperformance of each sector

Sector-Based Attribution

- Interaction
  - Who to attribute this outperformance to? Asset allocator or security selector?
  - Asset allocation without consideration of the security selector's skills

$$= \sum_s \left(w_s^P - w_s^B\right) \cdot \left(R_s^B - R^B\right) + \sum_s \boxed{w_s^P} \cdot \left(R_s^P - R_s^B\right)$$

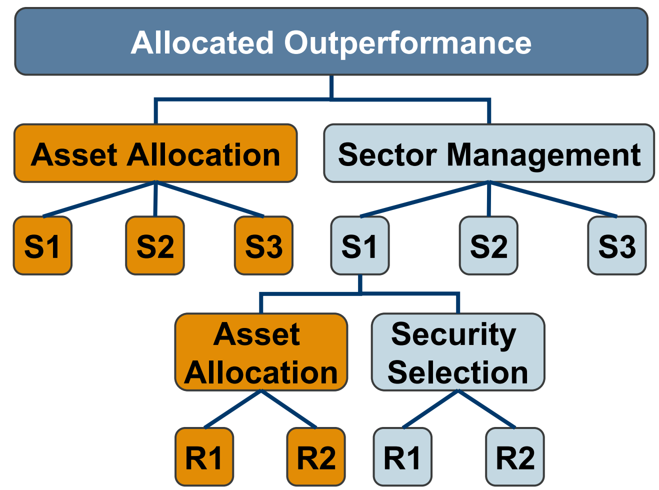
  - Security selection without consideration of portfolio weights

$$= \sum_s \left(w_s^P - w_s^B\right) \cdot \left(\boxed{R_s^P} - R^B\right) + \sum_s w_s^B \cdot \left(R_s^P - R_s^B\right)$$

Recursive Allocation to Subsectors

- Multi-level sector management
- Security selection = sector management
- Sector return as weighted sum of subsector returns

$$R_s^P = \sum_r \frac{w_r^P}{w_s^P} R_r^P, \qquad R_s^B = \sum_r \frac{w_r^B}{w_s^B} R_r^B$$



- Sector management decomposition to subsector level
- Asset allocation and security selection at subsector level constrained to sector-level weight, w_s [relative allocation]

$$w_s^P \cdot \left(R_s^P - R_s^B\right) = \sum_r \frac{w_r^P}{w_s^P} R_r^P - \sum_r \frac{w_r^B}{w_s^B} R_r^B$$

$$= w_s^P \sum_r \left(\frac{w_r^P}{w_s^P} - \frac{w_r^B}{w_s^B} \right) \cdot \left(R_r^B - R_s^H\right) + \sum_r w_r^P \cdot \left(R_r^P - R_r^B\right)$$

Example: Sector-Based

US Credit Portfolio versus Barclays Capital US Credit Corp Index

Partition	Market Weight (%)		Total Return		Outperformance (bps)	
Bucket	**Port**	**Bench**	**Port**	**Bench**	**Asset Allocation**	**Security Selection**
Total	**100.0**	**100.0**	**(18.0)**	**(78.1)**	**5.3**	**54.7**
Industrials	39.1	52.9	(114.3)	(113.4)	4.9	(0.3)
Utilities	**17.8**	**11.5**	**(5.6)**	**(168.1)**	**(5.7)**	**28.9**
Financial Inst.	43.0	35.4	65.5	4.2	6.3	26.2

Utilities: AA < SS

- Total outperformance of 60.1bps, most of it from security selection
- Overweight utilities while it was the worst performing sector
  - Negative asset allocation
- Negative return from utilities in portfolio, but significantly better than benchmark
  - Positive security selection
- If interaction is folded into asset allocation instead
  - Utilities: asset allocation = 4.6bps; security selection = 18.7bps
- What was the exposure to yield curve? Were the hedges effective?

Source: POINT.

Factor-Based Attribution

- Return as contribution of common risk factors and residual

$$R^P = \sum_k \alpha_k^P f_k + \varepsilon^P, \qquad R^B = \sum_k \alpha_k^B f_k + \varepsilon^B$$

- Outperformance decomposition (bottom-up)

$$R^P - R^B = \sum_k \alpha_k^P f_k + \varepsilon^P - \left(\sum_k \alpha_k^B f_k + \varepsilon^B \right)$$

$$= \sum_k \left(\alpha_k^P - \alpha_k^B\right) \cdot f_k + \left(\varepsilon^P - \varepsilon^B\right)$$

- Outperformance attributed to active exposure to each risk factor
- Idiosyncratic return does not get attributed

Example: Factor-Based

		Curve		Volatility			OAS			
Partition Bucket	Total	Carry	Change	Decay	Parallel	Reshaping	Carry	Change Duration	Change Convexity	Residual
Total	**60.1**	**(2.8)**	**62.9**	**0.0**	**(0.3)**	**0.4**	**0.8**	**4.0**	**0.2**	**0.0**
Industrials	15.3	(6.0)	21.3	0.0	(0.3)	0.3	(1.7)	(28.1)	(0.4)	0.0
Utilities	**18.4**	**(2.2)**	**20.5**	**0.0**	**0.0**	**0.0**	**0.7**	**(22.2)**	**(0.2)**	**0.2**
Financial Inst.	26.4	5.5	21.1	0.0	(0.1)	0.1	1.8	54.3	0.7	(0.2)

- Total outperformance of 60.1bps, most of it curve exposure
- Portfolio underweights “duration” (5.1 years vs. 6.4 years) while treasury yield increases
- Negative spread return because even though portfolio’s spread tightens more than benchmark, it is offset by smaller “spread duration” (0.9 years vs. 7.4 years)
- No information on asset allocation and security selection

Source: POINT.

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Hybrid Approach

Hybrid Approach

- Combines sector-based and factor-based attribution

- Idiosyncratic returns can be decomposed into asset allocation and security selection to each sector

$$
\begin{aligned}
R^P - R^B &= \sum_k \left(\alpha_k^P - \alpha_k^B\right) \cdot f_k + \left(\varepsilon^P - \varepsilon^B\right) \\
&= \underbrace{\sum_k \left(\alpha_k^P - \alpha_k^B\right) \cdot f_k}_{} + \underbrace{\sum_s w_s^P \varepsilon_s^P - \sum_s w_s^B \varepsilon_s^B}_{}
\end{aligned}
$$

Factor-based attribution
- Risk factor exposure

Sector-based attribution
- Asset allocation
- Sector management

- In fact, f_k can represent any number of risk factors, and ϵ should represent “excess” return being managed by in the asset allocation and security selection process

Excess of Curve Return Allocation

- Credit portfolio
- Sector managers manage excess (over curve) returns
- Decomposed return into yield curve and excess return

$$R^P = OAD^P \cdot \Delta y + ER^P,$$

- Curve is managed at portfolio level

Curve exposure $= \left(OAD^P - OAD^B\right) \cdot \Delta y$

- Excess return is managed by over / underweighting market values of sectors

Asset allocation $= \sum_s \left(w_s^P - w_s^B\right) \cdot \left(ER_s^B - ER^B\right)$

Sector management $= \sum_s w_s^P \cdot \left(ER_s^P - ER_s^B\right)$

Example: Excess of Curve Return

	Market Weight (%)		Curve Return		Excess Return		Outperformance (bps)		
Partition Bucket	Port	Bench	Port	Bench	Port	Bench	Curve	Asset Allocation	Security Selection
Total	**100.0**	**100.0**	**(262.2)**	**(316.4)**	**244.2**	**238.4**	**55.1**	**4.1**	**0.9**
Industrials	39.1	52.9	(332.6)	(331.6)	218.3	218.2	45.4	2.7	0.0
Utilities	**17.8**	**11.5**	**(14.9)**	**(368.4)**	**9.2**	**200.3**	**39.9**	**(2.3)**	**(34.3)**
Financial Inst.	43.0	35.4	(300.3)	(278.2)	365.8	282.4	(30.3)	3.2	35.2

Utilities: AA > SS

- Curve exposure managed at the portfolio level
  - Curve return does not contribute to asset allocation / security selection
- Security selection for utilities becomes significantly negative
- In pure sector-based model, it was significantly positive
- Significant underperformance in terms of excess return

Source: POINT.

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Extensions

Risk-Adjusted Return and Risk Weights

- Over / underweighting market values only makes sense for some asset classes, e.g., high yield
- Investment-grade managers express their views through other measures such as OASD
- Instead of market value weights, w_s, consider risk weights, β_s

$$ER^P - ER^B = \left(\beta^P - \beta^B\right) \cdot \frac{ER^B}{\beta^B} + \beta^P \left(\frac{ER^P}{\beta^P} - \frac{ER^B}{\beta^B} \right)$$

$$= \beta^P \sum_s \left(\frac{w_s^P \beta_s^P}{\beta^P} - \frac{w_s^B \beta_s^B}{\beta^B} \right) \cdot \left(\frac{ER_s^B}{\beta_s^B} - \frac{ER^H}{\beta^H} \right)$$

Asset Allocation

$$+ \sum_s w_s^P \beta_s^P \cdot \left(\frac{ER_s^P}{\beta_s^P} - \frac{ER_s^B}{\beta_s^B} \right)$$

Security Selection

$$+ \left(\beta^P - \beta^B\right) \cdot \frac{ER^B}{\beta^B}$$

Top-Level Risk Exposure / Leverage

Example: Risk-Adjusted Excess Return

$$\beta = OASD,\ \ ER/\beta \approx \Delta OAS$$

Partition Bucket	Market Weight (%) Port	Market Weight (%) Bench	OASD (yrs) Port	OASD (yrs) Bench	Risk-Adj Return Port	Risk-Adj Return Bench	Outperformance (bps) OASD Mismatch	Outperformance (bps) Asset Allocation	Outperformance (bps) Security Selection
Total	**100.0**	**100.0**	**4.9**	**6.2**	**49.4**	**38.7**	**(47.2)**	**20.1**	**33.2**
Industrials	39.1	52.9	6.2	6.5	35.0	33.5	–	(10.7)	3.5
Utilities	**17.8**	**11.5**	**0.9**	**7.4**	**10.6**	**27.1**	**–**	**(14.2)**	**(2.6)**
Financial Inst.	43.0	35.4	5.4	5.3	67.2	53.5	–	45.0	32.3

$$\beta = DTS \equiv OASD \cdot OAS,\ \ ER/\beta \approx \Delta OAS/OAS$$

Partition Bucket	Market Weight (%) Port	Market Weight (%) Bench	DTS (yrs*%) Port	DTS (yrs*%) Bench	Risk-Adj Return Port	Risk-Adj Return Bench	Outperformance (bps) DTS Mismatch	Outperformance (bps) Asset Allocation	Outperformance (bps) Security Selection
Total	**100.0**	**100.0**	**9.9**	**11.3**	**24.7**	**21.1**	**(29.3)**	**6.2**	**29.2**
Industrials	39.1	52.9	9.6	9.8	22.8	22.2	–	(18.3)	2.5
Utilities	**17.8**	**11.5**	**1.4**	**12.9**	**6.7**	**15.5**	**–**	**(16.3)**	**(2.2)**
Financial Inst.	43.0	35.4	13.7	13.0	26.7	21.8	–	40.8	29.0

- Significantly negative outperformance from leverage
  - Under exposed in terms both OASD and DTS
- Positive asset allocation and security selection

Utilities: AA < SS

Source: POINT.

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Outperformance from Market Timing

- Asset allocation decision made at the beginning of each month by specify "target" average sector weights, $\tilde{w}_s$
- Sector managers selects the securities and WHEN to enter the trades
- One way to extract outperformance from timing is to combine attribution results from monthly and daily calculations
- For simplicity, suppose that the target average weights are met exactly
  - Asset allocation is captured by monthly calculation using target weights
  - Security selection is captured by daily calculation
  - The remainder is contributed to market timing

	Market Weight (%)		Excess Return		Outperformance (bps)		
Partition Bucket	**Port**	**Bench**	**Port**	**Bench**	**Asset Allocation**	**Security Selection**	**Market Timing**
Total	**100.0**	**100.0**	**258.5**	**238.4**	**5.1**	**11.7**	**3.1**
Industrials	40.2	52.9	250.6	218.2	2.6	6.8	(0.1)
Utilities	**16.0**	**11.5**	**8.9**	**200.3**	**(1.7)**	**(33.5)**	**2.8**
Financial Inst.	43.8	35.4	381.6	282.4	3.7	38.4	0.5

Source: POINT.

Conclusion

- Two standard methodologies of performance attributions
  - Sector-based
  - Factor-based
- Hybrid approach
  - Return from exposure to common (risk) factors
  - Allocation decisions based on excess (over common factors) return
- Extensions
  - Using risk-weight and risk-adjusted return
  - Outperformance from market timing

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