Investment Management

Active Portfolio Management

Road Map

- The Efficient Markets Hypothesis (EMH) and ‘beating the market’
- Active portfolio management
  - Market timing
  - Security selection
- Security selection: Treynor&Black model
The problem

- Is it possible to beat the performance of a **passive** portfolio?
  - If markets are *fully efficient*, the answer is *NO*
  - But... what if markets are only *nearly efficient*
- **Active** portfolio management seeks to exploit perceived market inefficiencies
- Two forms of active portfolio management
  - market timing
  - security selection

Market inefficiency

- Actively-managed portfolios
  - are *not fully diversified*
  - may include *mispriced securities*
- Competition amongst active managers ensures that securities trade close to their *fair* values
  - on a risk-adjusted basis, most portfolio managers *will not* beat passive strategies
  - managers with exceptional skills and/or privileged information *can* beat passive strategies
- Some active managers *must* earn abnormal profits
  - otherwise ...
    - there would be no active portfolio managers
    - security prices would stray from *fair* values, inducing portfolio managers to adopt active strategies
Beating the market portfolio...

- Two techniques for improving performance:
  - adjust the **bond/stock mix** of the portfolio in anticipation of market changes
    - modify portfolio in favour of equities (bonds) if investor is “bullish” (“bearish”) about the stock market
  - adjust the **equity beta** of the portfolio
    - invest in high-beta (low-beta) stocks if investor is “bullish” (“bearish”) about the stock market
- Both techniques impact the average beta of the overall portfolio therefore we can use beta to measure how successful market timing has been

Market timing
Market timing:
Adjusting bond-stock mix

- Little evidence of market timing ability

Direct comparison
with market return

- Evaluate market timing by comparing the return on the portfolio with the return on the market
- **No market timing**
  - average beta of portfolio (fairly) constant
  - portfolio return is a constant fraction of return on market (assuming no specific risk)
- **Market timing**
  - high $\beta$ in rising market, low $\beta$ in falling market
  - portfolio return $> \text{market return}$
Evidence of market timing
(returns comparison)

Example: Merton’s exercise
– holding period 1 January 1927 - 31 December 1978
– investment strategies:
  1. invest $1000 in 30-day T-bills, rolled over every 30 days
  2. invest $1000 in NYSE index, and re-invest dividends
  3. invest $1000 in either 30-day T-bills or NYSE index, switching from one to the other every 30 days on the basis of perfect foresight (certainty)

How do the three strategies compare (December 1978)?

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy 1</td>
<td>All-safe asset</td>
<td>$3,600</td>
</tr>
<tr>
<td>Strategy 2</td>
<td>All-equity</td>
<td>$67,500</td>
</tr>
<tr>
<td>Strategy 3</td>
<td>Perfect foresight</td>
<td>$5,360,000,000</td>
</tr>
</tbody>
</table>
Market timing

- Why does perfect market timing result in such huge gains?
  - compounding over a large number of years
  - privileged information
- Monthly returns on NYSE index and switching portfolio ($\sigma_{\text{TBill}} = 2.10\%, \sigma_{\text{equities}} = 22.14\%$):

<table>
<thead>
<tr>
<th>Per Month</th>
<th>All Equities (%)</th>
<th>Perfect Timer No Charge (%)</th>
<th>Perfect Timer Fair Charge (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average rate of return</td>
<td>0.85</td>
<td>2.58</td>
<td>0.55</td>
</tr>
<tr>
<td>Average excess return over return on safe asset</td>
<td>0.64</td>
<td>2.37</td>
<td>0.34</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>5.89</td>
<td>3.82</td>
<td>3.55</td>
</tr>
<tr>
<td>Highest return</td>
<td>38.55</td>
<td>38.55</td>
<td>30.14</td>
</tr>
<tr>
<td>Lowest return</td>
<td>-29.12</td>
<td>0.06</td>
<td>-7.06</td>
</tr>
<tr>
<td>Coefficient of skewness</td>
<td>0.42</td>
<td>4.28</td>
<td>2.84</td>
</tr>
</tbody>
</table>

Security selection

- Aims at identifying **misprediced** securities which offer opportunity to achieve returns higher than pre-specified benchmarks (or the market portfolio)
- Problems:
  - adjusting composition of portfolio in favor of mispriced securities moves away from being full diversified
  - incur costs of carrying **specific** (or diversifiable) risk
- Trade-off between
  - achieving abnormal returns
  - reducing risk via diversification
Treynor-Black model: preamble

- The Treynor-Black model is a model embedding the use of security analysis.
- Analysts look at the market and investigate in depth only few securities (the others are assumed to be fairly priced). They form active portfolios as follows:
  - Estimate for each security betas and residual risk.
  - Given a certain equilibrium model (say the CAPM) the identify the magnitude of mispricing (alpha).
  - They also estimate the impact of holding a less than fully diversified portfolio looking at the variance of stock residuals (residual risk).
  - Given the estimates of betas, alphas and residual risks they compute the optimal weights of each security in the active portfolio.

Treynor-Black model: assumptions

- Assume:
  - there is a single common source of risk.
  - the market is nearly efficient (i.e. the CAPM/single index model nearly holds).
- Asset returns:
  \[ r_k = r_f + \beta_k (r_m - r_f) + e_k + \alpha_k \]
  where \( \alpha_k \) is the abnormal return (=Jensen’s alpha) of the mispriced assets \( k \).
- Expected return on active portfolio (comprising mispriced securities):
  \[ E(r_a) = \alpha_i + r_f + \beta_i [E(r_m) - r_f] \]
- With variance:
  \[ \sigma^2(r_a) = \beta_i^2 \sigma_m^2 + \sigma^2(e_i) \]
Treynor-Black model: intuition

The optimal active portfolio is a combination of the passive market portfolio and the active portfolio of mispriced securities.

How do we judge the success of the strategy? The mathematics of the efficient frontier reveals that

\[ S_P^2 = S_M^2 + \left( \frac{\alpha_A}{\sigma(A)} \right)^2 = S_M^2 + \sum_{i=1}^{N} \left( \frac{\alpha_i}{\sigma_i} \right)^2 \]

- Only for the optimal active portfolio (P), the Sharpe ratio (squared) is given by the sum of
  - the sharpe ratio of the (passive) market portfolio (squared)
  - the standardised degree of mispricing, appraisal ratio or information ratio, (squared)

Treynor-Black model: solution
Example

- Equity analyst in HK selects the following mispriced stocks:

<table>
<thead>
<tr>
<th></th>
<th>$\beta_i$</th>
<th>$E(r_i)$</th>
<th>$\sigma(e_i)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOC HK</td>
<td>0.60</td>
<td>20%</td>
<td>60%</td>
</tr>
<tr>
<td>MTR Corp</td>
<td>0.60</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td>Esprit Holdgs</td>
<td>0.50</td>
<td>14%</td>
<td>45%</td>
</tr>
<tr>
<td>Cathay Pac Air</td>
<td>0.20</td>
<td>8%</td>
<td>40%</td>
</tr>
</tbody>
</table>

- Other information: $E(r_M) = 10\%$, $\sigma_R = 25\%$, $R_F = 4\%$

Example (cont’d)

- **Step 1**: calculate expected abnormal returns and information ratios

  \[
  \alpha_i = E(r_i) - r_f - \beta_i [E(r_M) - r_f]
  \]

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_i$</th>
<th>$\alpha_i / \sigma(e_i)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOC HK</td>
<td>12.40%</td>
<td>0.21</td>
</tr>
<tr>
<td>MTR Corp</td>
<td>9.40%</td>
<td>0.19</td>
</tr>
<tr>
<td>Esprit Holdgs</td>
<td>7.00%</td>
<td>0.16</td>
</tr>
<tr>
<td>Cathay Pac Air</td>
<td>2.80%</td>
<td>0.07</td>
</tr>
</tbody>
</table>

- This implies a Sharpe ratio of the active portfolio of

  \[
  S_p = \sqrt{S_H^2 + \sum_{i=1}^{n} \left( \frac{\alpha_i}{\sigma(e_i)} \right)^2} = \\
  = \sqrt{(0.24)^2 + (0.21)^2 + (0.19)^2 + (0.16)^2 + (0.07)^2} = 0.41
  \]
**Example (cont’d)**

- **Step 2:** construct the active portfolio implied by the security analyst input list (*algebra is not required*)

\[
    w_i = \frac{\alpha_i / \sigma^2(e_i)}{\sum_{i=1}^{n} \alpha_i / \sigma^2(e_i)}
\]

<table>
<thead>
<tr>
<th></th>
<th>$\alpha_i / \sigma^2(e_i)$</th>
<th>$\sum_{i=1}^{n} \alpha_i / \sigma^2(e_i)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOC HK</td>
<td>0.124/(0.60^2) = 0.344</td>
<td>0.344/1.241 = 0.28</td>
</tr>
<tr>
<td>MTR Corp</td>
<td>0.094/(0.50^2) = 0.376</td>
<td>0.376/1.241 = 0.30</td>
</tr>
<tr>
<td>Esprit Holdgs</td>
<td>0.070/(0.45^2) = 0.346</td>
<td>0.346/1.241 = 0.28</td>
</tr>
<tr>
<td>Cathay Pac Air</td>
<td>0.028/(0.40^2) = 0.175</td>
<td>0.175/1.241 = 0.14</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td></td>
<td>1.241</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

The formed active portfolio exhibits the following estimates:

- $\alpha_s = \sum_{i=1}^{n} w_i \alpha_i = 0.28 \times 0.124 + 0.30 \times 0.094 + 0.07 \times 0.028 + 0.14 \times 0.086 = 0.86%$
- $\beta_s = \sum_{i=1}^{n} w_i \beta_i = 0.28 \times 0.6 + 0.30 \times 0.6 + 0.5 \times 0.02 = 0.516$
- $\sigma(e_s) = \sqrt{\sum_{i=1}^{n} w_i^2 \sigma^2(e_i)} = \sqrt{(0.28)^2 \times (0.60)^2 + (0.30)^2 \times (0.50)^2 + (0.07)^2 \times (0.28)^2 + (0.14)^2 \times (0.40)^2} = 0.264 (26.4%)$
Example (cont’d)

- The expected return and standard deviation of the active portfolio are equal to:

\[ E(r_A) = \alpha_A + r_f + \beta_A [E(r_M) - r_f] = 0.086 + 0.04 + 0.516[0.10 - 0.04] = 0.16 \text{ (16\%)} \]

\[ \sigma_A = \sqrt{\beta_A^2 \sigma_M^2 + \sigma^2(e)} = \sqrt{[(0.516)^2 (0.25)^2 + (0.264)^2} = 0.29 \text{ (29\%)} \]

\[ \text{cov}(r_A, r_M) = \beta_A \sigma_M^2 = 0.516 \times (0.25)^2 = 0.032 \]

\[ \rho(r_A, r_M) = \frac{\text{cov}(r_A, r_M)}{\sigma_A \sigma_M} = \frac{0.032}{0.29 \times 0.25} = 0.44 \]

Example (cont’d)

- **Step 3**: determine composition of the overall risky portfolio (active portfolio + market portfolio)

\[ w_0 = \frac{\alpha_A / \sigma_A^2}{\sigma_M^2} \rightarrow w^* = \frac{w_0}{1 + (1 - \beta_A) w_0} \]

where \( w^* \) denotes the share of the active portfolio within the overall risky portfolio. The weight attached to the market portfolio within the overall risky portfolio is given by \( 1 - w^* \)

- In our example:

\[ w_0 = \frac{0.086 / (0.264)^2}{(0.10 - 0.04) / (0.25)^2} = 1.29 \]

\[ w^* = \frac{1.29}{1 + (1 - 0.519) 1.29} = 0.80 \]
Example (cont’d)

<table>
<thead>
<tr>
<th></th>
<th>$w_i$</th>
<th>$w^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOC HK</td>
<td>$0.28 \times 0.80 = 0.22$</td>
<td></td>
</tr>
<tr>
<td>MTR Corp</td>
<td>$0.30 \times 0.80 = 0.24$</td>
<td></td>
</tr>
<tr>
<td>Esprit Holdgs</td>
<td>$0.28 \times 0.80 = 0.22$</td>
<td></td>
</tr>
<tr>
<td>Cathay Pac Air</td>
<td>$0.14 \times 0.80 = 0.11$</td>
<td></td>
</tr>
<tr>
<td><strong>Active portfolio</strong></td>
<td><strong>0.80</strong></td>
<td></td>
</tr>
<tr>
<td>Market portfolio</td>
<td></td>
<td><strong>0.20</strong></td>
</tr>
</tbody>
</table>

$S_A = 0.41 \gg S_M = 0.24$

Example (cont’d)

![Graph showing portfolio risk and expected return]
Treynor-Black model: summing up

- Optimizing model for portfolio managers who use
  security analysis under the assumption that markets
  are nearly efficient
  - security analysis can assess in depth only a small
    number of securities (securities not assessed are assumed
    to be fairly priced)
  - market index portfolio is the passive portfolio
  - perceived mispricing guides the composition of the
    active portfolio

Treynor-Black model: summing up

- analysts follow several steps to make up the
  portfolio and evaluate its expected performance
  1. Estimate beta and residual risk for each analysed
     security; from these, determine the required return
  2. Given the degree of mispricing, determine the expected
     return for each security (abnormal return)
  3. The nonsystematic risk component of the mispriced
     stock is the cost of not fully diversifying by specialising
     in underpriced securities
  4. Determine the optimal weight of each security in the
     active portfolio
  5. Determine the optimal risky portfolio, which is a
     combination of passive and active portfolios
  6. Compare CAL w.r.t CML
Readings

- BKM
  - Section 24.4, Chapter 27
- Other readings (optional)