Seminar 3
Introduction to backtesting: case of naïve 1/N strategy

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Satisfying vs optimal

- Simple rules are often far more robust than complicated "optimal" alternatives
- Rules of thumb work surprisingly well in a variety of fields (Haldane, 2012)
- Reasons:
  - "collecting and processing the information necessary for complex decision-making is costly"
  - "fully defining future states of the world, and probability-weighting them, is beyond anyone's cognitive limits"
- Oversimplifying things is obviously bad as well

Simplicity in portfolio theory

- "One should always divide his wealth into three parts: a third in land, a third in merchandise, and a third ready to hand."
- Source: Rabbi Isaac bar Aha, Babylonian Talmud: Tractate Baba Mezi'a, folio 42a, **4th century**
- Empirically valid statement
- Naïve, equal-weight portfolio frequently delivers better results than "optimal" allocation strategies (DeMiguel, 2005)
- Let's test this simple allocation strategy!

Steps of strategy evaluation

- Formally define rules for decision-making

- Collect data and clean it

- Simulate trading process

- Compare the results to the benchmark

- Compute performance metrics

Decision-making rules

- Distribute your initial capital equally between N stocks
- Wait☺
- Example:
  - Initial capital: $1000
  - 10 stocks
  - You invest $100 in each stock and stay away from the market for a while
- Looks simple!

Not so simple in fact

- How to choose N stocks (assets) to invest in?
- Infinite possible solutions:
  - All US stocks
  - All stocks in the world
  - All stocks, bonds, currencies, real estate – everything
  - Only stocks that satisfy specific conditions (most liquid stocks, stocks of the largest companies, stocks with low P/E ratio, etc.)
- Result crucially depends on the answer
- **Universe of securities** is a set of stocks (assets) you're focusing on

Universe of securities

- We will look at largest US companies by market capitalization
- Capitalization = Number of shares * Price of one share
- Components of Russell 1000
- Pay attention to the methodology of index (sections 6.1.1 and 6.10.1 in Russell_methodology.pdf)
- Russell 1000 defines universe of ~1000 largest US companies
- They account for ~90% of total market capitalization
- You can try S&P 500 and DJIA as well, or apply any custom filter: dividends, P/E, most volatile stocks, etc.

Data collection

- We need daily close prices for all Russell 1000 components
- Yahoo! Finance is one of the options
- Yahoo! close prices are now split adjusted
- Split example:
  - In June 2014 Apple shares were at ~$700 per share
  - A 7-to-1 split was implemented by Apple in June
  - Each stock you owned turned into 7 stocks and the price went down to ~$100
  - Split adjusted prices mean that all prices before the split are divided by 7
- Thanks Yahoo! for this adjustment!

Simulate trading process

- Compute allocations to selected stocks at day 1
- Track changes in values of each allocation
- $p_{t,j}$ - price of j-th stock at day t
- $\dfrac{p_{t,j}}{p_{t-1,j}}$ - stock return
- Suppose we make two investments at day $t-1$:
  - invest \$1 in AAPL (Apple)
  - Invest \$1 in KO (The Coca-Cola Co)
- Value of our portfolio at day t:

$$\$1 * \frac{p_{t,1}}{p_{t-1,1}} + \$1 * \frac{p_{t,2}}{p_{t-1,2}}$$
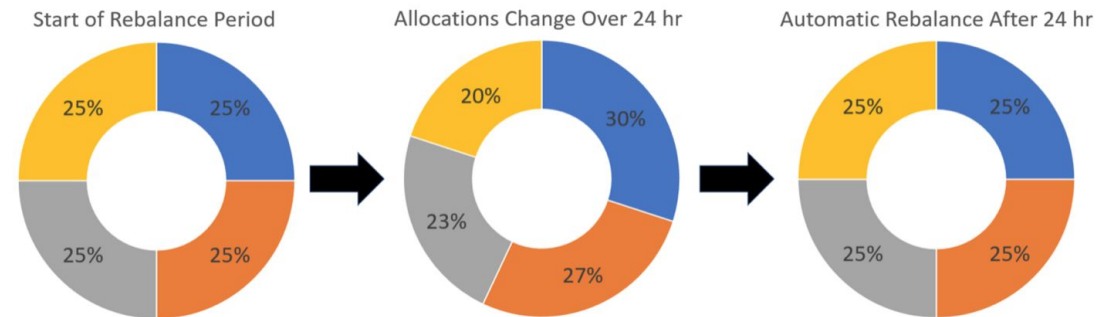
Compare result with the benchmark

- Passive investing is the frequently used benchmark
- "Passive" means we don't even compute allocation weights
- Our passive alternative: invest in S&P 500 (buy the market)
- In case of the previous example, invest \$2 in the index at day $t-1$
- sp_t - value of S&P 500 at day t
- Value of our passive portfolio at day t:

$$\$2 * \frac{sp_t}{sp_{t-1}}$$

Rebalancing

- Values of the allocations change in time
- Eventually the portfolio becomes imbalanced
- Periodic rebalancing is needed
  - daily
  - weekly
  - monthly
  - by any specific rule

Start of Rebalance Period

Allocations Change Over 24 hr

Automatic Rebalance After 24 hr

25% 25%
25% 25%

20% 30%
23% 27%

25% 25%
25% 25%

Simple illustration depicting how periodic rebalancing takes place at specific times. After 24 hours, the allocations are not equal, so a rebalance will make them equal once again.

Source: https://hackernoon.com

Backtest pitfalls

- Survivorship bias
  - we picked only companies that didn't go bankrupt
  - moreover, they were eventually included in Russell 1000 – we picked the best ones
- No trading costs
- Trading on close prices is impossible
- Stocks are not sold in fractions
- And many more pitfalls which we will discuss later☹️
- See "A Practitioner's Guide to Assessing Strategies and Avoiding Pitfalls" and chapter 3 of "Successful Algorithmic Trading" (M. Halls-Moore, 2015) for advanced details