Boilinger Strategy Backtesting

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September 22, 2023

This document is for me to take notes during creating the Boilinger backtesting project!

1 Tasks for backtesting

- Data (API + polish it to usable formats)
- Write the strategy
- Performance measurement functions
- Avoid biases (survivorship bias, data-snooping bias)
- Check out the transaction cost
- Strategy refinement = small variations to optimize performance

2 The strategy

The key idea behind Bollinger Bands is to analyze price volatility and identify potential price reversal points.

Here's a simplified explanation of the key components of the Bollinger Bands strategy:

1. **Bollinger Bands:** Bollinger Bands consist of three lines:

- **The middle band**, which is typically a simple moving average (SMA) of the price over a specified period.
- **The upper band**, which is the sum of the middle band and a multiple (usually 2) of the standard deviation of the price over the same period.
- **The lower band**, which is the difference between the middle band and the same multiple of the standard deviation.

2.**Volatility Measurement:** The standard deviation used in the calculation of the upper and lower bands is a measure of price volatility. When prices are more volatile, the bands widen, and when prices are less volatile, the bands narrow.

3. **Trading Signals:**

- **Buy Signal:** When the price touches or falls below the lower band, it's considered an oversold condition, and a potential buy signal is generated.
- **Sell Signal:** When the price touches or rises above the upper band, it's considered an overbought condition, and a potential sell signal is generated.

- **Stop-Loss and Take-Profit:** Traders often use stop-loss orders to limit potential losses if the trade goes against them and take-profit orders to lock in profits when the price reaches a certain favorable level.
- **Position Sizing:** Proper position sizing is crucial to manage risk. Traders determine the size of their positions based on their risk tolerance and the distance between the entry price and the stop-loss level.

4. **Confirmation:** Traders often use additional indicators or signals to confirm the buy or sell signals generated by Bollinger Bands. For example, they may look for other technical indicators or patterns.

3 Data

Things to consider which database to use :

1. **Split and Dividen adjusted?** = If you were looking at historical stock price data and didn't adjust for the split, it might appear as if the stock price suddenly dropped by half(for 2-for-1 stock split) on the day of the split.
2. **Survivorship-bias free?** Solution: Applying the strategy on both delisted stocks, stocks with high&small or big cap&small cap stocks to see how(if any) those qualities affect the performance
3. `Does your strategy use high or low data?` (tbd later)

- Decided to use **quandl** Python library for Data API requests

- Split data points into data input more model optimization and data testing

4 Performance measurement functions

4.1 Ralative and Logarithmic returns

4.2 Risk free rate

The risk-free rate is the theoretical return on an investment with zero risk of financial loss. It represents the minimum return an investor expects to earn for taking on zero risk. In practice, the risk-free rate is often approximated [1] using the yield on a government bond with a very short maturity, such as a Treasury bill. Key points to understand about the risk-free rate include:

- **Basis:** The risk-free rate serves as a baseline for comparing the returns of other investments. Any investment should ideally yield more than the risk-free rate to justify the additional risk it carries.
- **Use in Finance:** It's a crucial component in various financial calculations, including the pricing of assets, the valuation of stocks, and the assessment of investment performance.
- **Time Dependency:** The risk-free rate is not constant and can vary with the time horizon of the investment. Short-term investments typically use shorter-term risk-free rates, while long-term investments use longer-term rates.

[1] In practice, there are very few truly risk-free assets, but government bonds issued by stable governments are often considered the closest approximation.

4.3 Sharpe ratio

The Sharpe Ratio, developed by Nobel laureate William F. Sharpe, is a measure of the risk-adjusted performance of an investment portfolio or asset. It helps investors assess whether the excess return they receive for taking on additional risk is sufficient.

`Def :` $\langle return \rangle$ `earned in excess of the risk-free rate per unit of volatility.`

$$Sharpe\ \ ratio = \frac{Porfolio\ \ return - Risk\ \ free\ \ Rate}{Porfolio\ \ SD}$$

Note: All the returns/rates are calculated in relative return percentage

Key points:

- **Interpretation:** A Sharpe Ratio greater than 1 suggests that the portfolio is generating excess returns relative to its risk. A ratio less than 1 indicates that the returns may not justify the risk.
- **Comparison:** It's useful for comparing the risk-adjusted performance of different portfolios or assets. Investors can choose investments with higher Sharpe Ratios when seeking better risk-adjusted returns.
- **Limitations:** The Sharpe Ratio assumes that returns follow a normal distribution, which may not always hold in reality. It also assumes that investors are risk-averse and prefer higher returns for lower risk.

Calculation breakdowns:

- **Subtract the riskfree rate** from your strategy returns in calculating the Sharpe ratio only if your strategy incurs financing cost.
  Therefore, dollar neutral strategy, long-only day-trading strategy that does not hold positions overnight etc. don't require the riskfree rate subtraction!
- `Def : Annulised Sharpe ratio = to facilitate comparison across strategies`

  $$Annualised\ \ Sharpe\ \ ratio = \sqrt{N_T} * (Sharpe\ \ ratio)_T$$

  , where N_T is the number of trading periods (T) in a year
  Note: quick proof is the following

  1. Annual excess return = $N_T * (excesse\ \ return)_T$
  2. Annual SD return = N_T* mean sampled SD, where mean sampled SD = $\frac{SD_T}{\sqrt{N_T}}$

  Example, if your strategy holds positions only during the NYSE market hours (9:30–16:00 ET), and the average hourly returns is R^2, and the standard deviation of the hourly returns is s, then the annualized Sharpe ratio is $\sqrt{1638} * \frac{R}{s}$
  ,as N_T is = (252 trading days) × (6.5 trading hours per trading day) = 1,638.
  (A common mistake is to compute N_T as 252 × 24 = 6,048.)
- Rolling sharpe ratio = can be useful for analyzing the risk-adjusted performance of the investment over time. Check this link if interested.

[2] Check out how to calculate trading return from this tutorial

4.4 Maximum drawdown, Win rates

Other metrics to help deicde things

4.5 Variables to consider(for this backtesting):

1. SMA frequencies and SD multiplier
2. which assets
3. type of assets
4. time frame of the moving average
5. survivorship bias?