

# 04\_single\_factor\_zipline

September 29, 2021

## 1 Zipline Backtest with Single Factor

This notebook develops and test a simple mean-reversion factor that measures how much recent performance has deviated from the historical average. Short-term reversal is a common strategy that takes advantage of the weakly predictive pattern that stock price increases are likely to mean-revert back down over horizons from less than a minute to one month.

### 1.1 Imports & Settings

```
[1]: import warnings
     warnings.filterwarnings('ignore')
```

```
[2]: %matplotlib inline
     import matplotlib.pyplot as plt
     import seaborn as sns
```

```
[3]: sns.set_style('whitegrid')
```

We are first going to illustrate the zipline alpha factor research workflow in an offline environment. In particular, we will develop and test a simple mean-reversion factor that measures how much recent performance has deviated from the historical average.

Short-term reversal is a common strategy that takes advantage of the weakly predictive pattern that stock price increases are likely to mean-revert back down over horizons from less than a minute to one month.

To this end, the factor computes the z-score for the last monthly return relative to the rolling monthly returns over the last year. At this point, we will not place any orders to simply illustrate the implementation of a CustomFactor and record the results during the simulation.

After some basic settings, `MeanReversion` subclasses `CustomFactor` and defines a `compute()` method. It creates default inputs of monthly returns over an also default year-long window so that the `monthly_return` variable will have 252 rows and one column for each security in the Quandl dataset on a given day.

The `compute_factors()` method creates a `MeanReversion` factor instance and creates long, short, and ranking pipeline columns. The former two contain Boolean values that could be used to place orders, and the latter reflects that overall ranking to evaluate the overall factor performance. Furthermore, it uses the built-in `AverageDollarVolume` factor to limit the computation to more liquid stocks

The result would allow us to place long and short orders. We will see in the next chapter how to build a portfolio by choosing a rebalancing period and adjusting portfolio holdings as new signals arrive.

- The `initialize()` method registers the `compute_factors()` pipeline, and the `before_trading_start()` method ensures the pipeline runs on a daily basis.
- The `record()` function adds the pipeline's ranking column as well as the current asset prices to the performance DataFrame returned by the `run_algorithm()` function

Run using jupyter notebook extension

```
[4]: %load_ext zipline
```

Using the `quandl` bundle instead of the default `quantopian-quandl` because the latter has a bug that requires (manually) fixing the SQL database. If you have a file with benchmark returns you can provide this instead of `--no-benchmark` (see [docs](#)).

```
[5]: %%zipline --start 2015-1-1 --end 2018-1-1 --output single_factor.pickle
      ↪--no-benchmark --bundle quandl
```

```
from zipline.api import (
    attach_pipeline,
    date_rules,
    time_rules,
    order_target_percent,
    pipeline_output,
    record,
    schedule_function,
    get_open_orders,
    calendars
)
from zipline.finance import commission, slippage
from zipline.pipeline import Pipeline, CustomFactor
from zipline.pipeline.factors import Returns, AverageDollarVolume
import numpy as np
import pandas as pd

MONTH = 21
YEAR = 12 * MONTH
N_LONGS = N_SHORTS = 25
VOL_SCREEN = 1000

class MeanReversion(CustomFactor):
    """Compute ratio of latest monthly return to 12m average,
       normalized by std dev of monthly returns"""
    inputs = [Returns(window_length=MONTH)]
    window_length = YEAR
```

```

def compute(self, today, assets, out, monthly_returns):
    df = pd.DataFrame(monthly_returns)
    out[:] = df.iloc[-1].sub(df.mean()).div(df.std())

def compute_factors():
    """Create factor pipeline incl. mean reversion,
       filtered by 30d Dollar Volume; capture factor ranks"""
    mean_reversion = MeanReversion()
    dollar_volume = AverageDollarVolume(window_length=30)
    return Pipeline(columns={'longs': mean_reversion.bottom(N_LONGS),
                              'shorts': mean_reversion.top(N_SHORTS),
                              'ranking': mean_reversion.rank(ascending=False)},
                    screen=dollar_volume.top(VOL_SCREEN))

def exec_trades(data, assets, target_percent):
    """Place orders for assets using target portfolio percentage"""
    for asset in assets:
        if data.can_trade(asset) and not get_open_orders(asset):
            order_target_percent(asset, target_percent)

def rebalance(context, data):
    """Compute long, short and obsolete holdings; place trade orders"""
    factor_data = context.factor_data
    record(factor_data=factor_data.ranking)

    assets = factor_data.index
    record(prices=data.current(assets, 'price'))

    longs = assets[factor_data.longs]
    shorts = assets[factor_data.shorts]
    divest = set(context.portfolio.positions.keys()) - set(longs.union(shorts))

    exec_trades(data, assets=divest, target_percent=0)
    exec_trades(data, assets=longs, target_percent=1 / N_LONGS)
    exec_trades(data, assets=shorts, target_percent=-1 / N_SHORTS)

def initialize(context):
    """Setup: register pipeline, schedule rebalancing,
       and set trading params"""
    attach_pipeline(compute_factors(), 'factor_pipeline')
    schedule_function(rebalance,
                      date_rules.week_start(),
                      time_rules.market_open(),

```

```

calendar=calendars.US_EQUITIES)
context.set_commission(commission.PerShare(cost=.01, min_trade_cost=0))
context.set_slippage(slippage.VolumeShareSlippage())

def before_trading_start(context, data):
    """Run factor pipeline"""
    context.factor_data = pipeline_output('factor_pipeline')

```

```

[5]:
shorts_count    long_value    short_value    period_open    long_exposure    period_close    pnl
capital_used    short_exposure                                orders
...    sortino    max_drawdown    max_leverage    excess_return
treasury_period_return    trading_days    period_label    algorithm_period_return
factor_data                                prices
2015-01-02 21:00:00+00:00 2015-01-02 14:31:00+00:00 2015-01-02 21:00:00+00:00
0          0.000          0.000          0.000          0.000000  0.000000e+00
0.000                                []    ...    NaN
0.000000          0.000000          0.0          0.0          1
2015-01          0.000000
NaN                                NaN
2015-01-05 21:00:00+00:00 2015-01-05 14:31:00+00:00 2015-01-05 21:00:00+00:00
0          0.000          0.000          0.000          0.000000  0.000000e+00
0.000    [{'id': '4ef8337dc8614f9183a8e8a7a0df3c18', 'd...    ...    NaN
0.000000          0.000000          0.0          0.0          2
2015-01          0.000000    Equity(0 [A])          2707.0
Equity(2 [AAL]) ...    Equity(0 [A])          39.800
Equity(2 [AAL])...
2015-01-06 21:00:00+00:00 2015-01-06 14:31:00+00:00 2015-01-06 21:00:00+00:00
4  4731525.565 -1617262.705  4731525.565 -3799.475085 -3.118062e+06
-1617262.705    [{'id': '4ef8337dc8614f9183a8e8a7a0df3c18', 'd...    ...    -9.165151
-0.000380          0.635120          0.0          0.0          3
2015-01          -0.000380    Equity(0 [A])          2707.0
Equity(2 [AAL]) ...    Equity(0 [A])          39.800
Equity(2 [AAL])...
2015-01-07 21:00:00+00:00 2015-01-07 14:31:00+00:00 2015-01-07 21:00:00+00:00
4  4757100.850 -1629987.410  4757100.850 12850.580000  0.000000e+00
-1629987.410                                []    ...    18.918320
-0.000380          0.638131          0.0          0.0          4
2015-01          0.000905    Equity(0 [A])          2707.0
Equity(2 [AAL]) ...    Equity(0 [A])          39.800
Equity(2 [AAL])...
2015-01-08 21:00:00+00:00 2015-01-08 14:31:00+00:00 2015-01-08 21:00:00+00:00
4  4835941.280 -1645106.080  4835941.280 63721.760000  0.000000e+00
-1645106.080                                []    ...    135.877107
-0.000380          0.643422          0.0          0.0          5
2015-01          0.007277    Equity(0 [A])          2707.0

```

```

Equity(2 [AAL]) ... Equity(0 [A])          39.800
Equity(2 [AAL])...
...
...
...
...
...
...
2017-12-22 21:00:00+00:00 2017-12-22 14:31:00+00:00 2017-12-22 21:00:00+00:00
10 5266915.040 -4598653.320 5266915.040 -16960.030000 0.000000e+00
-4598653.320 [] ... 0.609931
-0.142578 1.259576 0.0 0.0 751
2017-12 0.102076 Equity(0 [A]) 2393.0
Equity(1 [AA]) ... Equity(0 [A]) 67.66
Equity(1 [AA]) ...
2017-12-26 21:00:00+00:00 2017-12-26 14:31:00+00:00 2017-12-26 21:00:00+00:00
10 5217746.950 -4592983.200 5217746.950 -43497.970000 0.000000e+00
-4592983.200 [{'id': 'fb0fdf179c8641beaec4f1bff3d1ca4', 'd... ... 0.587086
-0.142578 1.259576 0.0 0.0 752
2017-12 0.097727 Equity(0 [A]) 2363.0
Equity(1 [AA]) ... Equity(0 [A]) 67.25
Equity(1 [AA]) ...
2017-12-27 21:00:00+00:00 2017-12-27 14:31:00+00:00 2017-12-27 21:00:00+00:00
13 3966687.510 -5240774.395 3966687.510 41248.841483 1.940099e+06
-5240774.395 [{'id': 'fb0fdf179c8641beaec4f1bff3d1ca4', 'd... ... 0.607626
-0.142578 1.259576 0.0 0.0 753
2017-12 0.101852 Equity(0 [A]) 2363.0
Equity(1 [AA]) ... Equity(0 [A]) 67.25
Equity(1 [AA]) ...
2017-12-28 21:00:00+00:00 2017-12-28 14:31:00+00:00 2017-12-28 21:00:00+00:00
12 3967663.630 -5158764.315 3967663.630 25543.807669 -5.744239e+04
-5158764.315 [{'id': '5e21283eb12b47749c70fb46d0525f10', 'd... ... 0.620128
-0.142578 1.259576 0.0 0.0 754
2017-12 0.104406 Equity(0 [A]) 2363.0
Equity(1 [AA]) ... Equity(0 [A]) 67.25
Equity(1 [AA]) ...
2017-12-29 21:00:00+00:00 2017-12-29 14:31:00+00:00 2017-12-29 21:00:00+00:00
12 3953902.420 -5097704.930 3953902.420 47298.175000 0.000000e+00
-5097704.930 [] ... 0.643540
-0.142578 1.259576 0.0 0.0 755
2017-12 0.109136 Equity(0 [A]) 2363.0
Equity(1 [AA]) ... Equity(0 [A]) 67.25
Equity(1 [AA]) ...

```

[755 rows x 39 columns]

## 1.2 Inspect Results

We can get the result `DataFrame` using `_` which captures the last cell output (only works when you run it right after the above cell)

```
[6]: result = _
```

```
[7]: result.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 755 entries, 2015-01-02 21:00:00+00:00 to 2017-12-29
21:00:00+00:00
Data columns (total 39 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   period_open                          755 non-null    datetime64[ns, UTC]
1   period_close                         755 non-null    datetime64[ns, UTC]
2   shorts_count                        755 non-null    int64
3   long_value                          755 non-null    float64
4   short_value                         755 non-null    float64
5   long_exposure                      755 non-null    float64
6   pnl                                755 non-null    float64
7   capital_used                       755 non-null    float64
8   short_exposure                     755 non-null    float64
9   orders                             755 non-null    object
10  transactions                        755 non-null    object
11  positions                          755 non-null    object
12  gross_leverage                     755 non-null    float64
13  starting_exposure                  755 non-null    float64
14  net_leverage                       755 non-null    float64
15  ending_exposure                    755 non-null    float64
16  starting_value                     755 non-null    float64
17  ending_value                       755 non-null    float64
18  starting_cash                      755 non-null    float64
19  ending_cash                        755 non-null    float64
20  portfolio_value                    755 non-null    float64
21  returns                            755 non-null    float64
22  longs_count                        755 non-null    int64
23  algo_volatility                    754 non-null    float64
24  benchmark_period_return             755 non-null    float64
25  benchmark_volatility                754 non-null    float64
26  alpha                              0 non-null     object
27  beta                               0 non-null     object
28  sharpe                             753 non-null    float64
29  sortino                            753 non-null    float64
30  max_drawdown                       755 non-null    float64
31  max_leverage                       755 non-null    float64
32  excess_return                      755 non-null    float64
```

```

33 treasury_period_return    755 non-null    float64
34 trading_days              755 non-null    int64
35 period_label              755 non-null    object
36 algorithm_period_return    755 non-null    float64
37 factor_data               754 non-null    object
38 prices                    754 non-null    object
dtypes: datetime64[ns, UTC](2), float64(26), int64(3), object(8)
memory usage: 235.9+ KB

```

```

[8]: fig, axes = plt.subplots(nrows=2, figsize=(14,6))
result.algorithm_period_return.plot(ax=axes[0], title='Cumulative Return')
result.algo_volatility.plot(ax=axes[1], title='Volatility')
sns.despine()
fig.tight_layout();

```

