

# 08\_backtesting\_with\_zipline

September 29, 2021

## 1 Backtesting with zipline - Pipeline API with Custom Data

This notebook requires the conda environment `backtest`. Please see the [installation instructions](#) for running the latest Docker image or alternative ways to set up your environment.

### 1.1 Imports & Settings

```
[1]: from pathlib import Path
from collections import defaultdict
from time import time
import warnings

import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import pandas_datareader.data as web
from logbook import Logger, StderrHandler, INFO, WARNING

from zipline import run_algorithm
from zipline.api import (attach_pipeline, pipeline_output,
                        date_rules, time_rules, record,
                        schedule_function, commission, slippage,
                        set_slippage, set_commission, set_max_leverage,
                        order_target, order_target_percent,
                        get_open_orders, cancel_order)

from zipline.data import bundles
from zipline.utils.run_algo import load_extensions
from zipline.pipeline import Pipeline, CustomFactor
from zipline.pipeline.data import Column, DataSet
from zipline.pipeline.domain import US_EQUITIES
from zipline.pipeline.filters import StaticAssets
from zipline.pipeline.loaders import USEquityPricingLoader
from zipline.pipeline.loaders.frame import DataFrameLoader
from trading_calendars import get_calendar

import pyfolio as pf
```

```

from pyfolio.plotting import plot_rolling_returns, plot_rolling_sharpe
from pyfolio.timeseries import forecast_cone_bootstrap

from alphasens.tears import (create_returns_tear_sheet,
                             create_summary_tear_sheet,
                             create_full_tear_sheet)

from alphasens.performance import mean_return_by_quantile
from alphasens.plotting import plot_quantile_returns_bar
from alphasens.utils import get_clean_factor_and_forward_returns, rate_of_return

```

```

[2]: sns.set_style('whitegrid')
warnings.filterwarnings('ignore')
np.random.seed(42)
idx = pd.IndexSlice

```

```

[3]: results_path = Path('results', 'cnn_for_trading')
if not results_path.exists():
    results_path.mkdir()

```

## 1.2 Alphasens Analysis

```

[4]: DATA_STORE = Path '..', 'data', 'assets.h5')

```

```

[12]: def get_trade_prices(tickers):
        prices = (pd.read_hdf(DATA_STORE, 'quandl/wiki/prices').swaplevel().
        ↪sort_index())
        prices.index.names = ['symbol', 'date']
        prices = prices.loc[idx[tickers, '2010':'2018'], 'adj_open']
        return (prices
                .unstack('symbol')
                .sort_index()
                .shift(-1)
                .tz_localize('UTC'))

```

```

[13]: predictions = (pd.read_hdf(results_path / 'predictions.h5', 'predictions')
                    .iloc[:, :4]
                    .mean(1)
                    .to_frame('prediction'))

```

```

[14]: factor = (predictions
                .unstack('symbol')
                .asfreq('D')
                .dropna(how='all')
                .stack()
                .tz_localize('UTC', level='date'))

```

```

        .sort_index()
tickers = factor.index.get_level_values('symbol').unique()

```

```
[15]: factor.info()
```

```

<class 'pandas.core.frame.DataFrame'>
MultiIndex: 893670 entries, (2011-04-27 00:00:00+00:00, A) to (2017-12-28
00:00:00+00:00, ZTS)
Data columns (total 1 columns):
prediction      893670 non-null float32
dtypes: float32(1)
memory usage: 6.8+ MB

```

```
[16]: trade_prices = get_trade_prices(tickers)
```

```
[17]: trade_prices.info()
```

```

<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 2072 entries, 2010-01-04 to 2018-03-27
Columns: 600 entries, A to ZTS
dtypes: float64(600)
memory usage: 9.5 MB

```

```

[18]: factor_data = get_clean_factor_and_forward_returns(factor=factor,
                                                         prices=trade_prices,
                                                         quantiles=5,
                                                         periods=(1, 5, 10, 21)).
        ↪sort_index()
        factor_data.info()

```

Dropped 30.0% entries from factor data: 0.4% in forward returns computation and 29.6% in binning phase (set max\_loss=0 to see potentially suppressed Exceptions).

max\_loss is 35.0%, not exceeded: OK!

```

<class 'pandas.core.frame.DataFrame'>
MultiIndex: 625157 entries, (2011-04-27 00:00:00+00:00, A) to (2017-12-28
00:00:00+00:00, ZTS)
Data columns (total 6 columns):
1D                625157 non-null float64
5D                625157 non-null float64
10D               625157 non-null float64
21D               625157 non-null float64
factor            625157 non-null float32
factor_quantile   625157 non-null float64
dtypes: float32(1), float64(5)
memory usage: 28.6+ MB

```

```
[19]: create_summary_tear_sheet(factor_data);
```

#### Quantiles Statistics

	min	max	mean	std	count	count %
factor_quantile						
1.0	-0.005168	0.001667	0.000644	0.000625	125475	20.070958
2.0	-0.000586	0.001673	0.000684	0.000610	124853	19.971463
3.0	-0.000584	0.001677	0.000702	0.000606	124813	19.965065
4.0	-0.000582	0.001682	0.000715	0.000601	125301	20.043125
5.0	-0.000579	0.048656	0.000758	0.000784	124715	19.949389

#### Returns Analysis

	1D	5D	10D	21D
Ann. alpha	-0.092	-0.123	-0.089	-0.059
beta	0.053	0.107	0.130	0.253
Mean Period Wise Return Top Quantile (bps)	0.965	0.106	-0.185	-0.174
Mean Period Wise Return Bottom Quantile (bps)	-1.500	-1.164	-1.533	-1.526
Mean Period Wise Spread (bps)	2.465	1.244	1.315	1.322

#### Information Analysis

	1D	5D	10D	21D
IC Mean	0.008	0.011	0.015	0.014
IC Std.	0.143	0.139	0.137	0.128
Risk-Adjusted IC	0.056	0.079	0.108	0.106
t-stat(IC)	1.926	2.697	3.675	3.610
p-value(IC)	0.054	0.007	0.000	0.000
IC Skew	0.062	0.092	0.046	0.416
IC Kurtosis	0.351	0.730	0.265	0.631

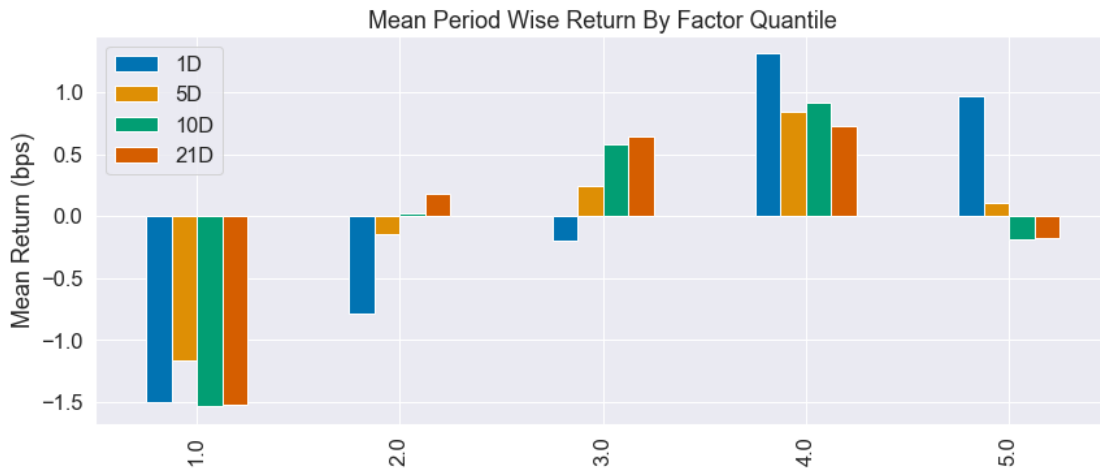
#### Turnover Analysis

	1D	5D	10D	21D
Quantile 1 Mean Turnover	0.236	0.480	0.604	0.708
Quantile 2 Mean Turnover	0.462	0.688	0.746	0.776
Quantile 3 Mean Turnover	0.497	0.709	0.761	0.783
Quantile 4 Mean Turnover	0.437	0.669	0.735	0.775
Quantile 5 Mean Turnover	0.218	0.455	0.582	0.691

	1D	5D	10D	21D
Mean Factor Rank Autocorrelation	0.876	0.588	0.388	0.194

<Figure size 432x288 with 0 Axes>



### 1.2.1 Load zipline extensions

Only need this in notebook to find bundle.

```
[20]: load_extensions(default=True,
                    extensions=[],
                    strict=True,
                    environ=None)

[21]: log_handler = StderrHandler(format_string='[{record.time:%Y-%m-%d %H:%M:%S.%f}]:
    ↳ ' +
                                '{record.level_name}: {record.func_name}: {record.
    ↳message}',
                                level=WARNING)
log_handler.push_application()
log = Logger('Algorithm')
```

## 1.3 Algo Params

```
[22]: N_LONGS = 25
N_SHORTS = 25
MIN_POSITIONS = 10
```

## 1.4 Load Data

### 1.4.1 Quandl Wiki Bundel

```
[23]: bundle_data = bundles.load('quandl')
```

### 1.4.2 ML Predictions

```
[26]: def load_predictions(bundle):
        predictions = (pd.read_hdf(results_path / 'predictions.h5', 'predictions')
                        .iloc[:, :4]
                        .mean(1)
                        .to_frame('prediction'))
        tickers = predictions.index.get_level_values('symbol').unique().tolist()

        assets = bundle.asset_finder.lookup_symbols(tickers, as_of_date=None)
        predicted_sids = pd.Int64Index([asset.sid for asset in assets])
        ticker_map = dict(zip(tickers, predicted_sids))

        return (predictions
                .unstack('symbol')
                .rename(columns=ticker_map)
                .prediction
                .tz_localize('UTC')), assets
```

```
[27]: predictions, assets = load_predictions(bundle_data)
```

```
[28]: predictions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 1680 entries, 2011-04-27 to 2017-12-28
Columns: 600 entries, 0 to 3197
dtypes: float32(600)
memory usage: 3.9 MB
```

### 1.4.3 Define Custom Dataset

```
[29]: class SignalData(DataSet):
        predictions = Column(dtype=float)
        domain = US_EQUITIES
```

### 1.4.4 Define Pipeline Loaders

```
[30]: signal_loader = {SignalData.predictions:
                        DataFrameLoader(SignalData.predictions, predictions)}
```

## 1.5 Pipeline Setup

### 1.5.1 Custom ML Factor

```
[31]: class MLSignal(CustomFactor):
        """Converting signals to Factor
           so we can rank and filter in Pipeline"""
        inputs = [SignalData.predictions]
```

```

window_length = 1

def compute(self, today, assets, out, predictions):
    out[:] = predictions

```

## 1.5.2 Create Pipeline

```

[32]: def compute_signals():
        signals = MLSignal()
        return Pipeline(columns={
            'longs' : signals.top(N_LONGS),
            'shorts': signals.bottom(N_SHORTS)},
            screen=StaticAssets(assets))

```

## 1.6 Initialize Algorithm

```

[33]: def initialize(context):
        """
        Called once at the start of the algorithm.
        """
        context.longs = context.shorts = None
        set_slippage(slippage.FixedSlippage(spread=0.00))
        # set_commission(commission.PerShare(cost=0.001, min_trade_cost=0))

        schedule_function(rebalance,
                           date_rules.every_day(),
        # date_rules.week_start(),
                           time_rules.market_open(hours=1, minutes=30))

        schedule_function(record_vars,
                           date_rules.every_day(),
                           time_rules.market_close())

        pipeline = compute_signals()
        attach_pipeline(pipeline, 'signals')

```

### 1.6.1 Get daily Pipeline results

```

[34]: def before_trading_start(context, data):
        """
        Called every day before market open.
        """
        output = pipeline_output('signals')
        longs = pipeline_output('signals').longs.astype(int)
        shorts = pipeline_output('signals').shorts.astype(int)
        holdings = context.portfolio.positions.keys()

```

```

if longs.sum() > MIN_POSITIONS and shorts.sum() > MIN_POSITIONS:
    context.longs = longs[longs!=0].index
    context.shorts = shorts[shorts!=0].index
    context.divest = holdings - set(context.longs) - set(context.shorts)
else:
    context.longs = context.shorts = pd.Index([])
    context.divest = set(holdings)

```

## 1.7 Define Rebalancing Logic

```

[35]: def rebalance(context, data):
    """
    Execute orders according to schedule_function() date & time rules.
    """

    for symbol, open_orders in get_open_orders().items():
        for open_order in open_orders:
            cancel_order(open_order)

    for stock in context.divest:
        order_target(stock, target=0)

    # log.warning('{} {}'.format(len(context.portfolio.positions), context.
    # portfolio.portfolio_value))
    if not (context.longs.empty and context.shorts.empty):
        for stock in context.shorts:
            order_target_percent(stock, -1 / len(context.shorts) / 2)
        for stock in context.longs:
            order_target_percent(stock, 1 / len(context.longs))

```

## 1.8 Record Data Points

```

[36]: def record_vars(context, data):
    """
    Plot variables at the end of each day.
    """
    record(leverage=context.account.leverage,
           longs=context.longs,
           shorts=context.shorts)

```



## 1.9 Run Algorithm

```
[37]: dates = predictions.index.get_level_values('date')
      start_date, end_date = dates.min(), dates.max()
```

```
[38]: print('Start: {} \nEnd:   {}'.format(start_date.date(), end_date.date()))
```

Start: 2011-04-27

End: 2017-12-28

```
[39]: start = time()
      results = run_algorithm(start=start_date,
                             end=end_date,
                             initialize=initialize,
                             before_trading_start=before_trading_start,
                             capital_base=1e5,
                             data_frequency='daily',
                             bundle='quandl',
                             custom_loader=signal_loader) # need to modify zipline

      print('Duration: {:.2f}s'.format(time() - start))
```

[2020-06-22 18:19:33.792272]: WARNING: ensure\_benchmark\_data: Still don't have expected benchmark data for 'SPY' from 1989-12-29 00:00:00+00:00 to 2020-06-22 00:00:00+00:00 after redownload!

[2020-06-22 18:20:34.915988]: WARNING: \_can\_order\_asset: Cannot place order for ACE, as it has de-listed. Any existing positions for this asset will be liquidated on 2016-01-15 00:00:00+00:00.

[2020-06-22 18:20:43.103276]: WARNING: \_can\_order\_asset: Cannot place order for RAX, as it has de-listed. Any existing positions for this asset will be liquidated on 2016-11-03 00:00:00+00:00.

Duration: 81.91s

## 1.10 PyFolio Analysis

```
[40]: returns, positions, transactions = pf.utils.
      ↪extract_rets_pos_txn_from_zipline(results)
```

```
[44]: benchmark = web.DataReader('SP500', 'fred', '2010', '2018').squeeze()
      benchmark = benchmark.pct_change().tz_localize('UTC')
```

### 1.10.1 Custom Plots

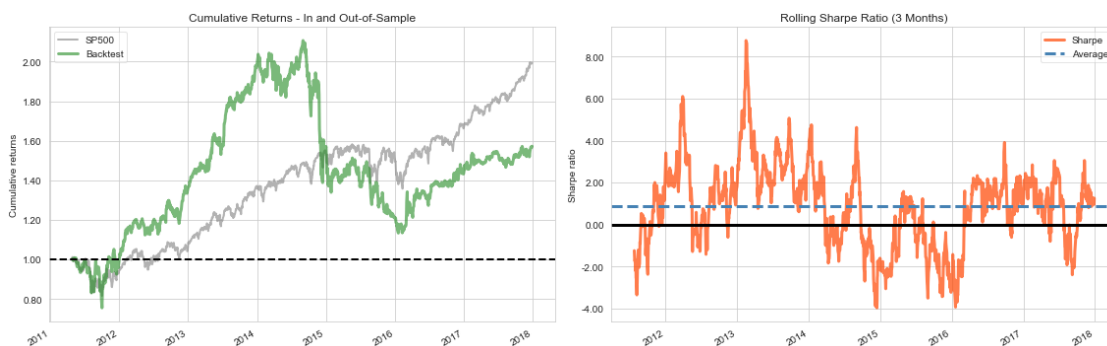
```
[45]: LIVE_DATE = '2018-01-01'
```

```
[47]: fig, axes = plt.subplots(ncols=2, figsize=(16, 5))
      plot_rolling_returns(returns,
```

```

        factor_returns=benchmark,
        live_start_date=LIVE_DATE,
        logy=False,
        cone_std=2,
        legend_loc='best',
        volatility_match=False,
        cone_function=forecast_cone_bootstrap,
        ax=axes[0])
plot_rolling_sharpe(returns, ax=axes[1], rolling_window=63)
axes[0].set_title('Cumulative Returns - In and Out-of-Sample')
axes[1].set_title('Rolling Sharpe Ratio (3 Months)')
fig.tight_layout()
fig.savefig((results_path / 'pyfolio_out_of_sample').as_posix(), dpi=300)

```



### 1.10.2 Tear Sheets

```

[48]: pf.create_full_tear_sheet(returns,
        positions=positions,
        transactions=transactions,
        benchmark_rets=benchmark,
        round_trips=True)

```

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

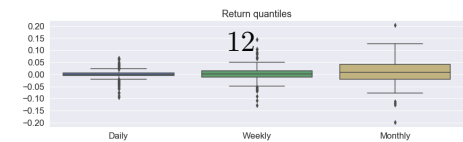
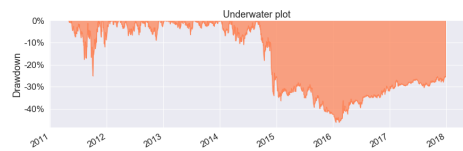
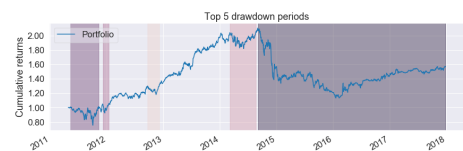
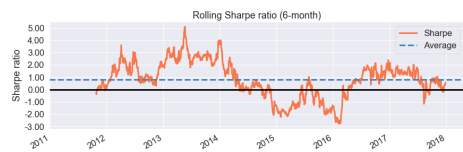
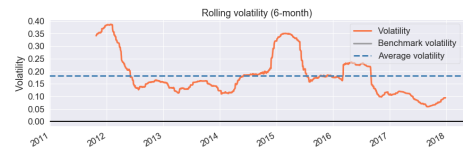
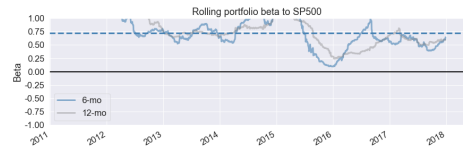
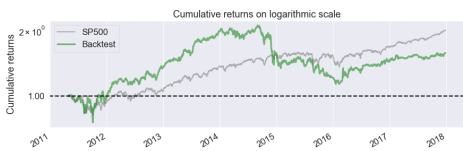
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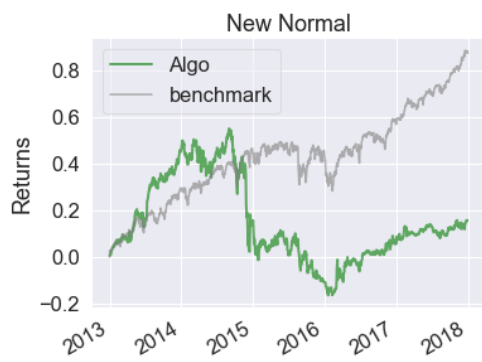
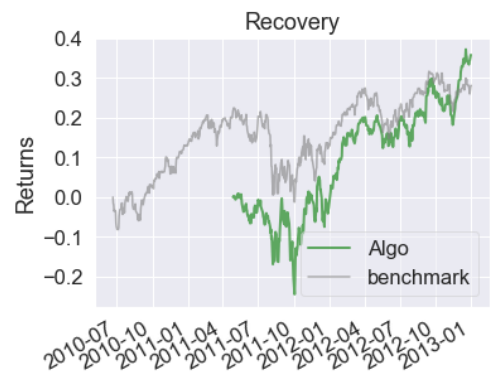
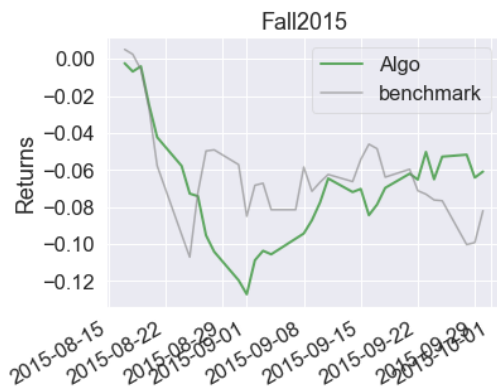
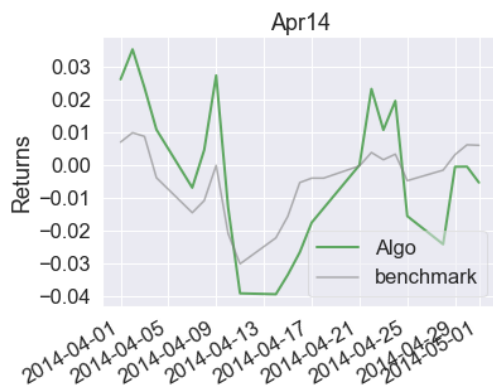
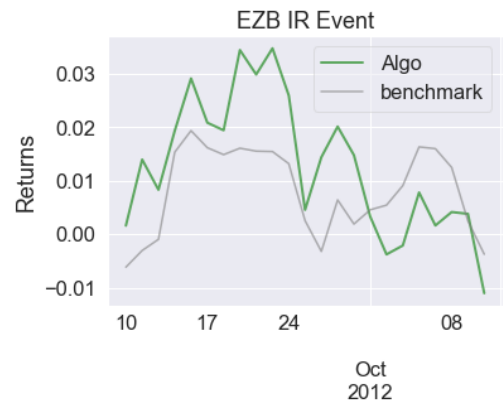
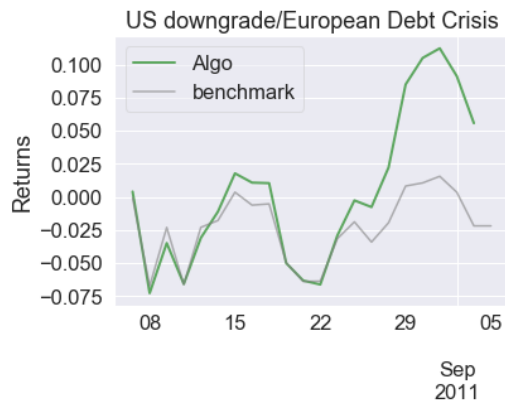
<IPython.core.display.HTML object>

<IPython.core.display.HTML object>

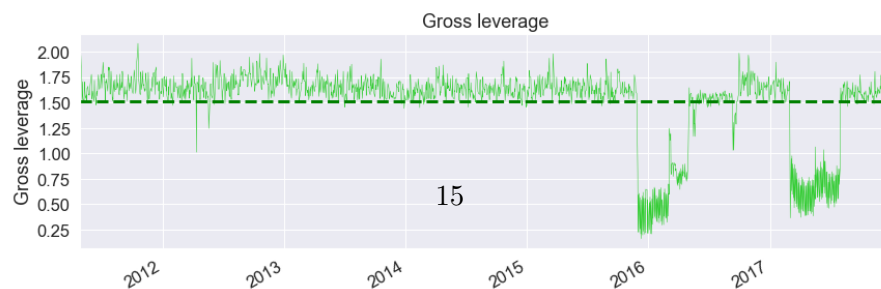
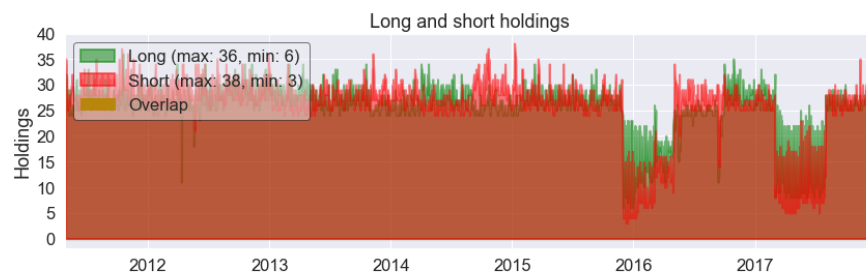
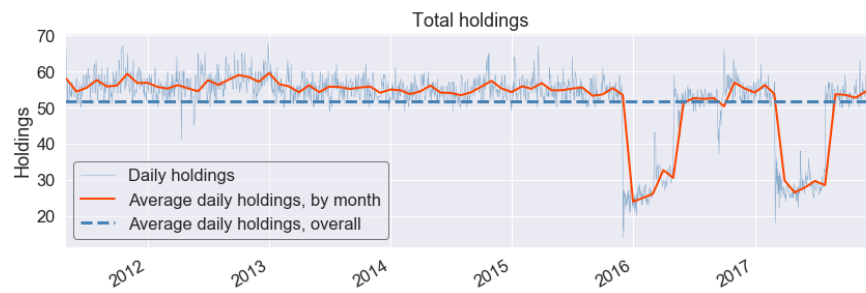
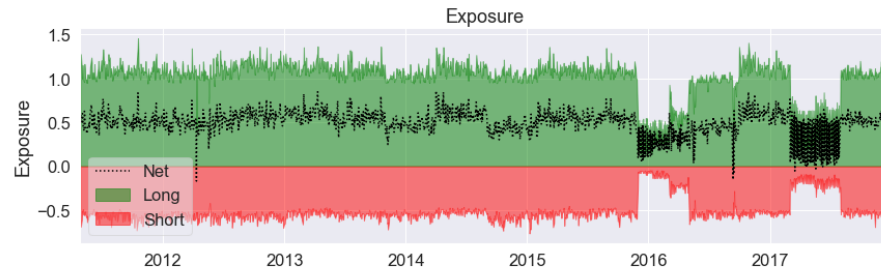
<IPython.core.display.HTML object>

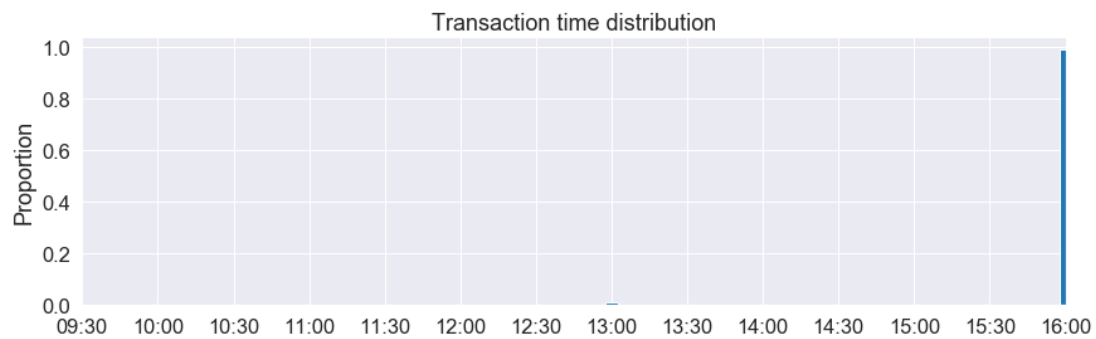
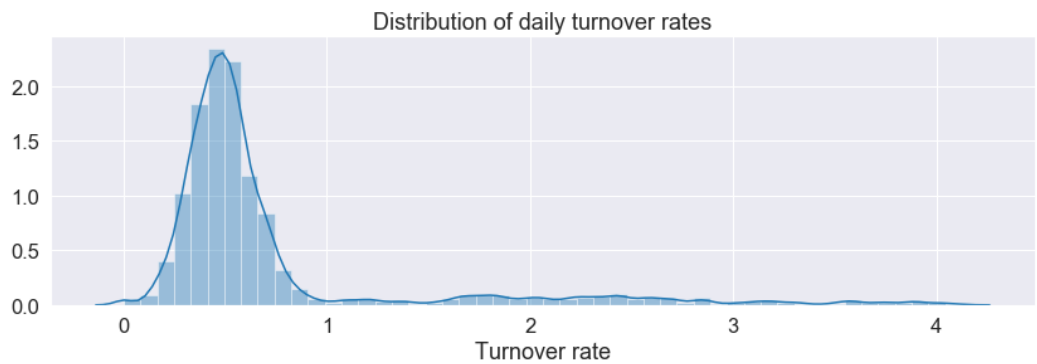
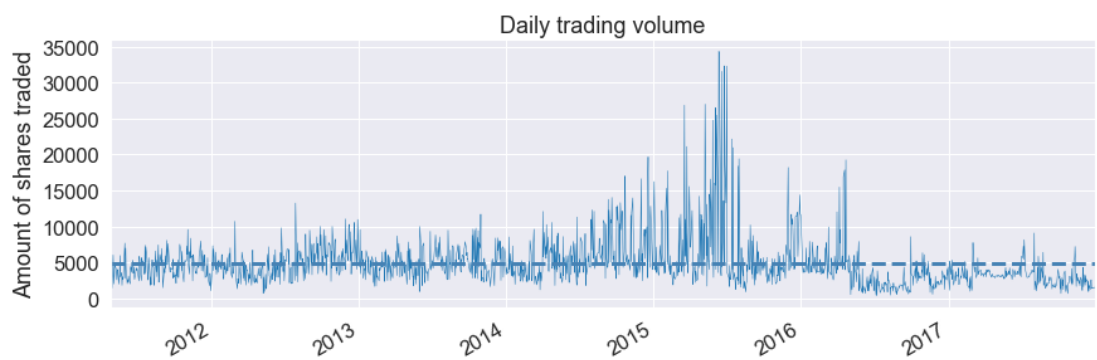
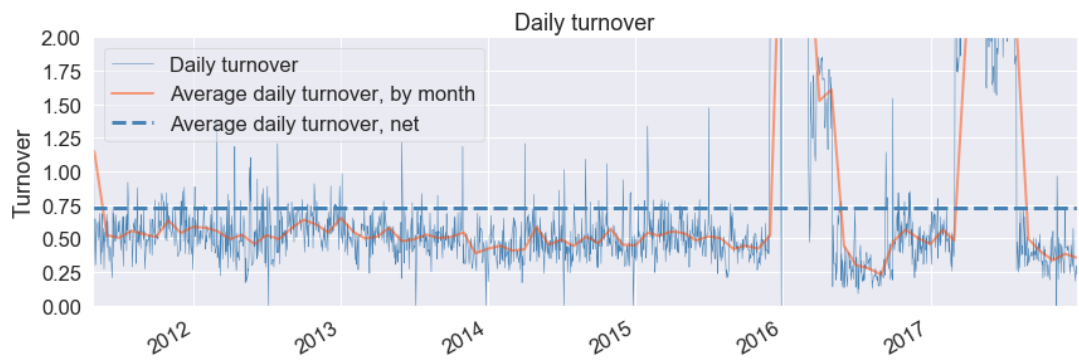
<IPython.core.display.HTML object>



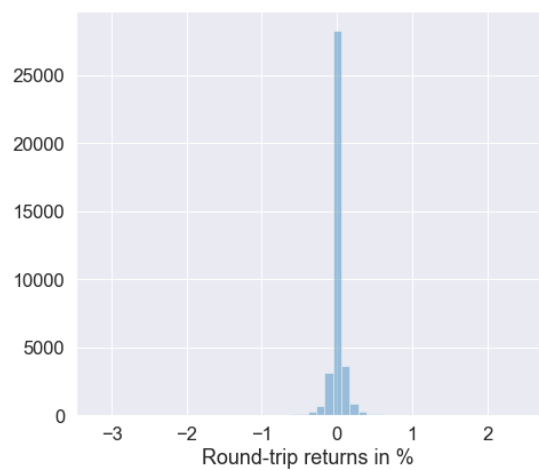
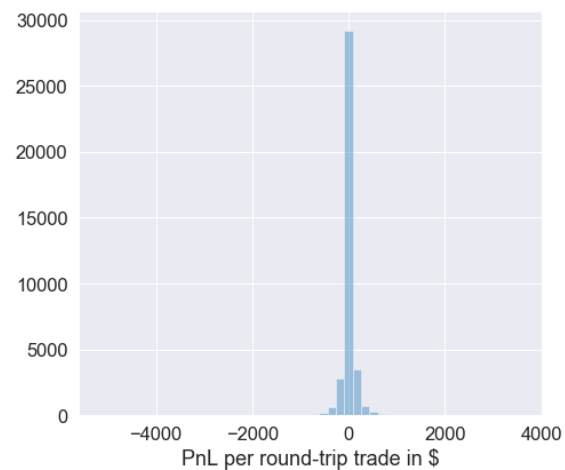
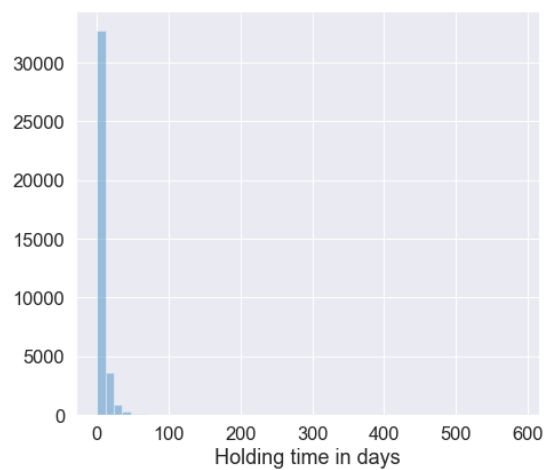
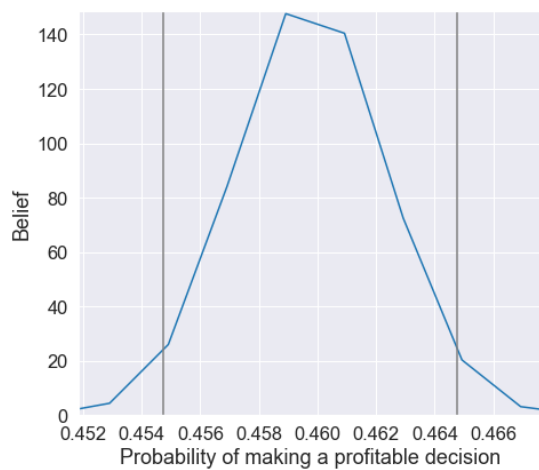
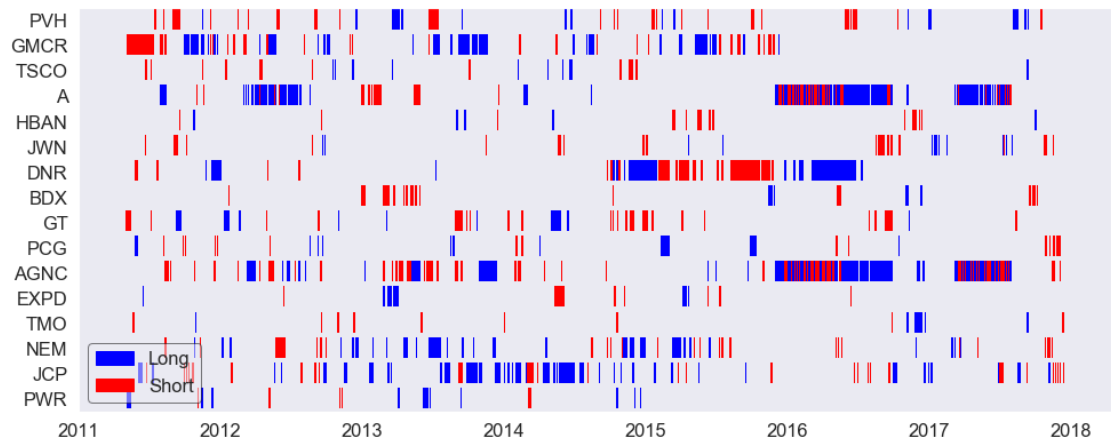












[ ]: