factor_library

September 29, 2021

1 Alpha Factor Library

This notebook contains a mumber of alpha factor candidates that we can use as features in ML models on the Quantopian platform.

[277]:
```
import pandas as pd
import numpy as np
from time import time
import talib
import re
from statsmodels.api import OLS
from sklearn.metrics import mean_squared_error
from scipy.stats import spearmanr
from sklearn.linear_model import LinearRegression, Ridge, RidgeCV, Lasso,␣
↪LassoCV, LogisticRegression
from sklearn.preprocessing import StandardScaler

from quantopian.research import run_pipeline
from quantopian.pipeline import Pipeline, factors, filters, classifiers
from quantopian.pipeline.data.builtin import USEquityPricing
from quantopian.pipeline.factors import (Latest,
                                         Returns,
                                         AverageDollarVolume,
                                         SimpleMovingAverage,
                                         EWMA,
                                         BollingerBands,
                                         CustomFactor,
                                         MarketCap,
                                        SimpleBeta)
from quantopian.pipeline.filters import QTradableStocksUS, StaticAssets
from quantopian.pipeline.data.quandl import fred_usdontd156n as libor
from empyrical import max_drawdown, sortino_ratio

import seaborn as sns
import matplotlib.pyplot as plt
```

1.1 Data Sources

[3]:
```
################
# Fundamentals #
################

# Morningstar fundamentals (2002 - Ongoing)
# https://www.quantopian.com/help/fundamentals
from quantopian.pipeline.data import Fundamentals

#####################
# Analyst Estimates #
#####################

# Earnings Surprises - Zacks (27 May 2006 - Ongoing)
# https://www.quantopian.com/data/zacks/earnings_surprises
from quantopian.pipeline.data.zacks import EarningsSurprises
from quantopian.pipeline.factors.zacks import␣
↪BusinessDaysSinceEarningsSurprisesAnnouncement

##########
# Events #
##########

# Buyback Announcements - EventVestor (01 Jun 2007 - Ongoing)
# https://www.quantopian.com/data/eventvestor/buyback_auth
from quantopian.pipeline.data.eventvestor import BuybackAuthorizations
from quantopian.pipeline.factors.eventvestor import BusinessDaysSinceBuybackAuth

# CEO Changes - EventVestor (01 Jan 2007 - Ongoing)
# https://www.quantopian.com/data/eventvestor/ceo_change
from quantopian.pipeline.data.eventvestor import CEOChangeAnnouncements

# Dividends - EventVestor (01 Jan 2007 - Ongoing)
# https://www.quantopian.com/data/eventvestor/dividends
from quantopian.pipeline.data.eventvestor import (
    DividendsByExDate,
    DividendsByPayDate,
    DividendsByAnnouncementDate,
)
from quantopian.pipeline.factors.eventvestor import (
    BusinessDaysSincePreviousExDate,
    BusinessDaysUntilNextExDate,
    BusinessDaysSinceDividendAnnouncement,
)

# Earnings Calendar - EventVestor (01 Jan 2007 - Ongoing)
```

```python
# https://www.quantopian.com/data/eventvestor/earnings_calendar
from quantopian.pipeline.data.eventvestor import EarningsCalendar
from quantopian.pipeline.factors.eventvestor import (
    BusinessDaysUntilNextEarnings,
    BusinessDaysSincePreviousEarnings
)

# 13D Filings - EventVestor (01 Jan 2007 - Ongoing)
# https://www.quantopian.com/data/eventvestor/_13d_filings
from quantopian.pipeline.data.eventvestor import _13DFilings
from quantopian.pipeline.factors.eventvestor import␣
↪BusinessDaysSince13DFilingsDate

#############
# Sentiment #
#############

# News Sentiment - Sentdex Sentiment Analysis (15 Oct 2012 - Ongoing)
# https://www.quantopian.com/data/sentdex/sentiment
from quantopian.pipeline.data.sentdex import sentiment
```

1.1.1 Setup

[4]:
```python
# trading days per period
MONTH = 21
YEAR = 12 * MONTH
```

[5]:
```python
START = '2014-01-01'
END = '2015-12-31'
```

Universe

[6]:
```python
def Q100US():
    return filters.make_us_equity_universe(
        target_size=100,
        rankby=factors.AverageDollarVolume(window_length=200),
        mask=filters.default_us_equity_universe_mask(),
        groupby=classifiers.fundamentals.Sector(),
        max_group_weight=0.3,
        smoothing_func=lambda f: f.downsample('month_start'),
    )
```

[7]:
```python
# UNIVERSE = StaticAssets(symbols(['MSFT', 'AAPL']))
UNIVERSE = Q100US()
```

[8]:
```python
class AnnualizedData(CustomFactor):
    # Get the sum of the last 4 reported values
```

```
    window_length = 260

    def compute(self, today, assets, out, asof_date, values):
        for asset in range(len(assets)):
            # unique asof dates indicate availability of new figures
            _, filing_dates = np.unique(asof_date[:, asset], return_index=True)
            quarterly_values = values[filing_dates[-4:], asset]
            # ignore annual windows with <4 quarterly data points
            if len(~np.isnan(quarterly_values)) != 4:
                out[asset] = np.nan
            else:
                out[asset] = np.sum(quarterly_values)
```

[9]:
```
class AnnualAvg(CustomFactor):
    window_length = 252

    def compute(self, today, assets, out, values):
        out[:] = (values[0] + values[-1])/2
```

[10]:
```
def factor_pipeline(factors):
    start = time()
    pipe = Pipeline({k: v(mask=UNIVERSE).rank() for k, v in factors.items()},
                    screen=UNIVERSE)
    result = run_pipeline(pipe, start_date=START, end_date=END)
    return result, time() - start
```

1.1.2 Value Factors

[11]:
```
class ValueFactors:
    """Definitions of factors for cross-sectional trading algorithms"""

    @staticmethod
    def PriceToSalesTTM(**kwargs):
        """Last closing price divided by sales per share"""
        return Fundamentals.ps_ratio.latest

    @staticmethod
    def PriceToEarningsTTM(**kwargs):
        """Closing price divided by earnings per share (EPS)"""
        return Fundamentals.pe_ratio.latest

    @staticmethod
    def PriceToDilutedEarningsTTM(mask):
        """Closing price divided by diluted EPS"""
        last_close = USEquityPricing.close.latest
        diluted_eps = AnnualizedData(inputs = [Fundamentals.
↪diluted_eps_earnings_reports_asof_date,
```

```
                                                Fundamentals.
↪diluted_eps_earnings_reports],
                                      mask=mask)
        return last_close / diluted_eps

    @staticmethod
    def PriceToForwardEarnings(**kwargs):
        """Price to Forward Earnings"""
        return Fundamentals.forward_pe_ratio.latest

    @staticmethod
    def DividendYield(**kwargs):
        """Dividends per share divided by closing price"""
        return Fundamentals.trailing_dividend_yield.latest

    @staticmethod
    def PriceToFCF(mask):
        """Price to Free Cash Flow"""
        last_close = USEquityPricing.close.latest
        fcf_share = AnnualizedData(inputs = [Fundamentals.
↪fcf_per_share_asof_date,
                                              Fundamentals.fcf_per_share],
                                    mask=mask)
        return last_close / fcf_share

    @staticmethod
    def PriceToOperatingCashflow(mask):
        """Last Close divided by Operating Cash Flows"""
        last_close = USEquityPricing.close.latest
        cfo_per_share = AnnualizedData(inputs = [Fundamentals.
↪cfo_per_share_asof_date,
                                                  Fundamentals.cfo_per_share],
                                        mask=mask)
        return last_close / cfo_per_share

    @staticmethod
    def PriceToBook(mask):
        """Closing price divided by book value"""
        last_close = USEquityPricing.close.latest
        book_value_per_share = AnnualizedData(inputs = [Fundamentals.
↪book_value_per_share_asof_date,
                                               Fundamentals.
↪book_value_per_share],
                                              mask=mask)
        return last_close / book_value_per_share
```

```python
    @staticmethod
    def EVToFCF(mask):
        """Enterprise Value divided by Free Cash Flows"""
        fcf = AnnualizedData(inputs = [Fundamentals.free_cash_flow_asof_date,
                                       Fundamentals.free_cash_flow],
                             mask=mask)
        return Fundamentals.enterprise_value.latest / fcf

    @staticmethod
    def EVToEBITDA(mask):
        """Enterprise Value to Earnings Before Interest, Taxes, Deprecation and␣
↪Amortization (EBITDA)"""
        ebitda = AnnualizedData(inputs = [Fundamentals.ebitda_asof_date,
                                          Fundamentals.ebitda],
                                mask=mask)

        return Fundamentals.enterprise_value.latest / ebitda

    @staticmethod
    def EBITDAYield(mask):
        """EBITDA divided by latest close"""
        ebitda = AnnualizedData(inputs = [Fundamentals.ebitda_asof_date,
                                          Fundamentals.ebitda],
                                mask=mask)
        return USEquityPricing.close.latest / ebitda
```

[12]:
```python
VALUE_FACTORS = {
    'DividendYield'             : ValueFactors.DividendYield,
    'EBITDAYield'               : ValueFactors.EBITDAYield,
    'EVToEBITDA'                : ValueFactors.EVToEBITDA,
    'EVToFCF'                   : ValueFactors.EVToFCF,
    'PriceToBook'               : ValueFactors.PriceToBook,
    'PriceToDilutedEarningsTTM': ValueFactors.PriceToDilutedEarningsTTM,
    'PriceToEarningsTTM'        : ValueFactors.PriceToEarningsTTM,
    'PriceToFCF'                : ValueFactors.PriceToFCF,
    'PriceToForwardEarnings'    : ValueFactors.PriceToForwardEarnings,
    'PriceToOperatingCashflow' : ValueFactors.PriceToOperatingCashflow,
    'PriceToSalesTTM'           : ValueFactors.PriceToSalesTTM,
}
```

[13]:
```python
value_result, t = factor_pipeline(VALUE_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
value_result.info()
```

```
/usr/local/lib/python2.7/dist-packages/numpy/lib/arraysetops.py:200:
FutureWarning: In the future, NAT != NAT will be True rather than False.
  flag = np.concatenate(([True], aux[1:] != aux[:-1]))
```

```
Pipeline run time 91.12 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 11 columns):
DividendYield                40772 non-null float64
EBITDAYield                  49823 non-null float64
EVToEBITDA                   49823 non-null float64
EVToFCF                      46400 non-null float64
PriceToBook                  50343 non-null float64
PriceToDilutedEarningsTTM    50215 non-null float64
PriceToEarningsTTM           48956 non-null float64
PriceToFCF                   49133 non-null float64
PriceToForwardEarnings       39607 non-null float64
PriceToOperatingCashflow     50343 non-null float64
PriceToSalesTTM              50362 non-null float64
dtypes: float64(11)
memory usage: 4.6+ MB
```

1.1.3 Momentum

[14]:
```python
class MomentumFactors:
    """Custom Momentum Factors"""
    class PercentAboveLow(CustomFactor):
        """Percentage of current close above low
        in lookback window of window_length days
        """
        inputs = [USEquityPricing.close]
        window_length = 252

        def compute(self, today, assets, out, close):
            out[:] = close[-1] / np.min(close, axis=0) - 1

    class PercentBelowHigh(CustomFactor):
        """Percentage of current close below high
        in lookback window of window_length days
        """

        inputs = [USEquityPricing.close]
        window_length = 252

        def compute(self, today, assets, out, close):
            out[:] = close[-1] / np.max(close, axis=0) - 1

    @staticmethod
    def make_dx(timeperiod=14):
        class DX(CustomFactor):
```

```python
            """Directional Movement Index"""
            inputs = [USEquityPricing.high,
                      USEquityPricing.low,
                      USEquityPricing.close]
            window_length = timeperiod + 1

            def compute(self, today, assets, out, high, low, close):
                out[:] = [talib.DX(high[:, i],
                                   low[:, i],
                                   close[:, i],
                                   timeperiod=timeperiod)[-1]
                          for i in range(len(assets))]
        return DX

    @staticmethod
    def make_mfi(timeperiod=14):
        class MFI(CustomFactor):
            """Money Flow Index"""
            inputs = [USEquityPricing.high,
                      USEquityPricing.low,
                      USEquityPricing.close,
                      USEquityPricing.volume]
            window_length = timeperiod + 1

            def compute(self, today, assets, out, high, low, close, vol):
                out[:] = [talib.MFI(high[:, i],
                                    low[:, i],
                                    close[:, i],
                                    vol[:, i],
                                    timeperiod=timeperiod)[-1]
                          for i in range(len(assets))]
        return MFI

    @staticmethod
    def make_oscillator(fastperiod=12, slowperiod=26, matype=0):
        class PPO(CustomFactor):
            """12/26-Day Percent Price Oscillator"""
            inputs = [USEquityPricing.close]
            window_length = slowperiod

            def compute(self, today, assets, out, close_prices):
                out[:] = [talib.PPO(close,
                                    fastperiod=fastperiod,
                                    slowperiod=slowperiod,
                                    matype=matype)[-1]
                         for close in close_prices.T]
        return PPO
```

```
    @staticmethod
    def make_stochastic_oscillator(fastk_period=5, slowk_period=3,␣
↪slowd_period=3,
                                   slowk_matype=0, slowd_matype=0):
        class StochasticOscillator(CustomFactor):
            """20-day Stochastic Oscillator """
            inputs = [USEquityPricing.high,
                      USEquityPricing.low,
                      USEquityPricing.close]
            outputs = ['slowk', 'slowd']
            window_length = fastk_period * 2

            def compute(self, today, assets, out, high, low, close):
                slowk, slowd = [talib.STOCH(high[:, i],
                                            low[:, i],
                                            close[:, i],
                                            fastk_period=fastk_period,
                                            slowk_period=slowk_period,
                                            slowk_matype=slowk_matype,
                                            slowd_period=slowd_period,
                                            slowd_matype=slowd_matype)[-1]
                                for i in range(len(assets))]

                out.slowk[:], out.slowd[:] = slowk[-1], slowd[-1]
        return StochasticOscillator

    @staticmethod
    def make_trendline(timeperiod=252):
        class Trendline(CustomFactor):
            inputs = [USEquityPricing.close]
            """52-Week Trendline"""
            window_length = timeperiod

            def compute(self, today, assets, out, close_prices):
                out[:] = [talib.LINEARREG_SLOPE(close,
                                   timeperiod=timeperiod)[-1]
                          for close in close_prices.T]
        return Trendline
```

[15]:
```
MOMENTUM_FACTORS = {
    'Percent Above Low'            : MomentumFactors.PercentAboveLow,
    'Percent Below High'           : MomentumFactors.PercentBelowHigh,
    'Price Oscillator'             : MomentumFactors.make_oscillator(),
    'Money Flow Index'             : MomentumFactors.make_mfi(),
    'Directional Movement Index'   : MomentumFactors.make_dx(),
    'Trendline'                    : MomentumFactors.make_trendline()
```

```
}
```

[16]:
```
momentum_result, t = factor_pipeline(MOMENTUM_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
momentum_result.info()
```

```
Pipeline run time 20.53 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 6 columns):
Directional Movement Index    50362 non-null float64
Money Flow Index              50362 non-null float64
Percent Above Low             49536 non-null float64
Percent Below High            49536 non-null float64
Price Oscillator              50355 non-null float64
Trendline                     49536 non-null float64
dtypes: float64(6)
memory usage: 2.7+ MB
```

1.1.4 Efficiency

[17]:
```
class EfficiencyFactors:

    @staticmethod
    def CapexToAssets(mask):
        """Capital Expenditure divided by Total Assets"""
        capex = AnnualizedData(inputs = [Fundamentals.
 ↪capital_expenditure_asof_date,
                                         Fundamentals.capital_expenditure],
                                     mask=mask)
        assets = Fundamentals.total_assets.latest
        return - capex / assets

    @staticmethod
    def CapexToSales(mask):
        """Capital Expenditure divided by Total Revenue"""
        capex = AnnualizedData(inputs = [Fundamentals.
 ↪capital_expenditure_asof_date,
                                         Fundamentals.capital_expenditure],
                                     mask=mask)
        revenue = AnnualizedData(inputs = [Fundamentals.total_revenue_asof_date,
                                         Fundamentals.total_revenue],
                                     mask=mask)
        return - capex / revenue

    @staticmethod
```

```
    def CapexToFCF(mask):
        """Capital Expenditure divided by Free Cash Flows"""
        capex = AnnualizedData(inputs = [Fundamentals.
↪capital_expenditure_asof_date,
                                        Fundamentals.capital_expenditure],
                                    mask=mask)
        free_cash_flow = AnnualizedData(inputs = [Fundamentals.
↪free_cash_flow_asof_date,
                                        Fundamentals.free_cash_flow],
                                    mask=mask)
        return - capex / free_cash_flow

    @staticmethod
    def EBITToAssets(mask):
        """Earnings Before Interest and Taxes (EBIT) divided by Total Assets"""
        ebit = AnnualizedData(inputs = [Fundamentals.ebit_asof_date,
                                        Fundamentals.ebit],
                                    mask=mask)
        assets = Fundamentals.total_assets.latest
        return ebit / assets

    @staticmethod
    def CFOToAssets(mask):
        """Operating Cash Flows divided by Total Assets"""
        cfo = AnnualizedData(inputs = [Fundamentals.
↪operating_cash_flow_asof_date,
                                        Fundamentals.operating_cash_flow],
                                    mask=mask)
        assets = Fundamentals.total_assets.latest
        return cfo / assets

    @staticmethod
    def RetainedEarningsToAssets(mask):
        """Retained Earnings divided by Total Assets"""
        retained_earnings = AnnualizedData(inputs = [Fundamentals.
↪retained_earnings_asof_date,
                                        Fundamentals.retained_earnings],
                                    mask=mask)
        assets = Fundamentals.total_assets.latest
        return retained_earnings / assets
```

[18]:

```
EFFICIENCY_FACTORS = {
    'CFO To Assets' :EfficiencyFactors.CFOToAssets,
    'Capex To Assets' :EfficiencyFactors.CapexToAssets,
    'Capex To FCF' :EfficiencyFactors.CapexToFCF,
    'Capex To Sales' :EfficiencyFactors.CapexToSales,
    'EBIT To Assets' :EfficiencyFactors.EBITToAssets,
```

```
    'Retained Earnings To Assets' :EfficiencyFactors.RetainedEarningsToAssets
    }
```

[19]:
```
efficiency_result, t = factor_pipeline(EFFICIENCY_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
efficiency_result.info()
```

```
Pipeline run time 35.88 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 6 columns):
CFO To Assets                  50351 non-null float64
Capex To Assets                46997 non-null float64
Capex To FCF                   45799 non-null float64
Capex To Sales                 46997 non-null float64
EBIT To Assets                 46635 non-null float64
Retained Earnings To Assets    50349 non-null float64
dtypes: float64(6)
memory usage: 2.7+ MB
```

1.1.5 Risk

[20]:
```
class RiskFactors:

    @staticmethod
    def LogMarketCap(mask):
        """Log of Market Capitalization log(Close Price * Shares Outstanding)"""
        return np.log(MarketCap(mask=mask))

    class DownsideRisk(CustomFactor):
        """Mean returns divided by std of 1yr daily losses (Sortino Ratio)"""
        inputs = [USEquityPricing.close]
        window_length = 252

        def compute(self, today, assets, out, close):
            ret = pd.DataFrame(close).pct_change()
            out[:] = ret.mean().div(ret.where(ret<0).std())

    @staticmethod
    def MarketBeta(**kwargs):
        """Slope of 1-yr regression of price returns against index returns"""
        return SimpleBeta(target=symbols('SPY'), regression_length=252)

    class DownsideBeta(CustomFactor):
        """Slope of 1yr regression of returns on negative index returns"""
        inputs = [USEquityPricing.close]
```

```
        window_length = 252

        def compute(self, today, assets, out, close):
            t = len(close)
            assets = pd.DataFrame(close).pct_change()

            start_date = (today - pd.DateOffset(years=1)).strftime('%Y-%m-%d')
            spy = get_pricing('SPY',
                              start_date=start_date,
                              end_date=today.strftime('%Y-%m-%d')).
↪reset_index(drop=True)
            spy_neg_ret = (spy
                           .close_price
                           .iloc[-t:]
                           .pct_change()
                           .pipe(lambda x: x.where(x<0)))

            out[:] = assets.apply(lambda x: x.cov(spy_neg_ret)).div(spy_neg_ret.
↪var())

    class Vol3M(CustomFactor):
        """3-month Volatility: Standard deviation of returns over 3 months"""

        inputs = [USEquityPricing.close]
        window_length = 63

        def compute(self, today, assets, out, close):
            out[:] = np.log1p(pd.DataFrame(close).pct_change()).std()
```

[21]:
```
RISK_FACTORS = {
    'Log Market Cap' : RiskFactors.LogMarketCap,
    'Downside Risk'  : RiskFactors.DownsideRisk,
    'Index Beta'     : RiskFactors.MarketBeta,
#     'Downside Beta'  : RiskFactors.DownsideBeta,
    'Volatility 3M'  : RiskFactors.Vol3M,
}
```

[22]:
```
risk_result, t = factor_pipeline(RISK_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
risk_result.info()
```

```
Pipeline run time 46.10 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 4 columns):
Downside Risk     50362 non-null float64
```

```
Index Beta        50079 non-null float64
Log Market Cap    50362 non-null float64
Volatility 3M     50362 non-null float64
dtypes: float64(4)
memory usage: 1.9+ MB
```

1.1.6 Growth

[23]:
```
def growth_pipeline():
    revenue = AnnualizedData(inputs = [Fundamentals.total_revenue_asof_date,
                                       Fundamentals.total_revenue],
                             mask=UNIVERSE)
    eps = AnnualizedData(inputs = [Fundamentals.
 ↪diluted_eps_earnings_reports_asof_date,
                                       Fundamentals.
 ↪diluted_eps_earnings_reports],
                             mask=UNIVERSE)

    return Pipeline({'Sales': revenue,
                     'EPS': eps,
                     'Total Assets': Fundamentals.total_assets.latest,
                     'Net Debt': Fundamentals.net_debt.latest},
                    screen=UNIVERSE)
```

[24]:
```
start_timer = time()
growth_result = run_pipeline(growth_pipeline(), start_date=START, end_date=END)

for col in growth_result.columns:
    for month in [3, 12]:
        new_col = col + ' Growth {}M'.format(month)
        kwargs = {new_col: growth_result[col].pct_change(month*MONTH).
 ↪groupby(level=1).rank()}
        growth_result = growth_result.assign(**kwargs)
print('Pipeline run time {:.2f} secs'.format(time() - start_timer))
growth_result.info()
```

```
Pipeline run time 22.21 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 12 columns):
EPS                    50215 non-null float64
Net Debt               47413 non-null float64
Sales                  50351 non-null float64
Total Assets           50362 non-null float64
EPS Growth 3M          50152 non-null float64
EPS Growth 12M         49963 non-null float64
Net Debt Growth 3M     47350 non-null float64
```

```
Net Debt Growth 12M        47171 non-null float64
Sales Growth 3M            50288 non-null float64
Sales Growth 12M           50099 non-null float64
Total Assets Growth 3M     50299 non-null float64
Total Assets Growth 12M    50110 non-null float64
dtypes: float64(12)
memory usage: 5.0+ MB
```

1.1.7 Quality

[25]:
```
class QualityFactors:

    @staticmethod
    def AssetTurnover(mask):
        """Sales divided by average of year beginning and year end assets"""

        assets = AnnualAvg(inputs=[Fundamentals.total_assets],
                           mask=mask)
        sales = AnnualizedData([Fundamentals.total_revenue_asof_date,
                                Fundamentals.total_revenue], mask=mask)
        return sales / assets

    @staticmethod
    def CurrentRatio(mask):
        """Total current assets divided by total current liabilities"""

        assets = Fundamentals.current_assets.latest
        liabilities = Fundamentals.current_liabilities.latest
        return assets / liabilities

    @staticmethod
    def AssetToEquityRatio(mask):
        """Total current assets divided by common equity"""

        assets = Fundamentals.current_assets.latest
        equity = Fundamentals.common_stock.latest
        return assets / equity


    @staticmethod
    def InterestCoverage(mask):
        """EBIT divided by interest expense"""

        ebit = AnnualizedData(inputs = [Fundamentals.ebit_asof_date,
                                        Fundamentals.ebit], mask=mask)
```

```
        interest_expense = AnnualizedData(inputs = [Fundamentals.
↪interest_expense_asof_date,
                                            Fundamentals.interest_expense],␣
↪mask=mask)
        return ebit / interest_expense

    @staticmethod
    def DebtToAssetRatio(mask):
        """Total Debts divided by Total Assets"""

        debt = Fundamentals.total_debt.latest
        assets = Fundamentals.total_assets.latest
        return debt / assets

    @staticmethod
    def DebtToEquityRatio(mask):
        """Total Debts divided by Common Stock Equity"""

        debt = Fundamentals.total_debt.latest
        equity = Fundamentals.common_stock.latest
        return debt / equity

    @staticmethod
    def WorkingCapitalToAssets(mask):
        """Current Assets less Current liabilities (Working Capital) divided by␣
↪Assets"""

        working_capital = Fundamentals.working_capital.latest
        assets = Fundamentals.total_assets.latest
        return working_capital / assets

    @staticmethod
    def WorkingCapitalToSales(mask):
        """Current Assets less Current liabilities (Working Capital), divided␣
↪by Sales"""

        working_capital = Fundamentals.working_capital.latest
        sales = AnnualizedData([Fundamentals.total_revenue_asof_date,
                                Fundamentals.total_revenue], mask=mask)
        return working_capital / sales


    class MertonsDD(CustomFactor):
        """Merton's Distance to Default """

        inputs = [Fundamentals.total_assets,
                  Fundamentals.total_liabilities,
```

```
                 libor.value,
                 USEquityPricing.close]
        window_length = 252

        def compute(self, today, assets, out, tot_assets, tot_liabilities, r,␣
↪close):
            mertons = []

            for col_assets, col_liabilities, col_r, col_close in zip(tot_assets.
↪T, tot_liabilities.T,
                                                                     r.T, close.
↪T):
                vol_1y = np.nanstd(col_close)
                numerator = np.log(
                        col_assets[-1] / col_liabilities[-1]) + ((252 *␣
↪col_r[-1]) - ((vol_1y ** 2) / 2))
                mertons.append(numerator / vol_1y)

            out[:] = mertons
```

[26]:
```
QUALITY_FACTORS = {
    'AssetToEquityRatio'    : QualityFactors.AssetToEquityRatio,
    'AssetTurnover'         : QualityFactors.AssetTurnover,
    'CurrentRatio'          : QualityFactors.CurrentRatio,
    'DebtToAssetRatio'      : QualityFactors.DebtToAssetRatio,
    'DebtToEquityRatio'     : QualityFactors.DebtToEquityRatio,
    'InterestCoverage'      : QualityFactors.InterestCoverage,
    'MertonsDD'             : QualityFactors.MertonsDD,
    'WorkingCapitalToAssets': QualityFactors.WorkingCapitalToAssets,
    'WorkingCapitalToSales' : QualityFactors.WorkingCapitalToSales,
}
```

[27]:
```
quality_result, t = factor_pipeline(QUALITY_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
quality_result.info()
```

```
Pipeline run time 34.41 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 9 columns):
AssetToEquityRatio        45176 non-null float64
AssetTurnover             50314 non-null float64
CurrentRatio              45680 non-null float64
DebtToAssetRatio          50080 non-null float64
DebtToEquityRatio         48492 non-null float64
```

```
InterestCoverage          35250 non-null float64
MertonsDD                 50362 non-null float64
WorkingCapitalToAssets    45680 non-null float64
WorkingCapitalToSales     45669 non-null float64
dtypes: float64(9)
memory usage: 3.8+ MB
```

1.1.8 Payout

[28]:
```
class PayoutFactors:

    @staticmethod
    def DividendPayoutRatio(mask):
        """Dividends Per Share divided by Earnings Per Share"""

        dps = AnnualizedData(inputs = [Fundamentals.
↪dividend_per_share_earnings_reports_asof_date,
                                       Fundamentals.
↪dividend_per_share_earnings_reports], mask=mask)

        eps = AnnualizedData(inputs = [Fundamentals.
↪basic_eps_earnings_reports_asof_date,
                                       Fundamentals.
↪basic_eps_earnings_reports], mask=mask)
        return dps / eps

    @staticmethod
    def DividendGrowth(**kwargs):
        """Annualized percentage DPS change"""
        return Fundamentals.dps_growth.latest
```

[29]:
```
PAYOUT_FACTORS = {
    'Dividend Payout Ratio': PayoutFactors.DividendPayoutRatio,
    'Dividend Growth': PayoutFactors.DividendGrowth
}
```

[30]:
```
payout_result, t = factor_pipeline(PAYOUT_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
payout_result.info()
```

```
Pipeline run time 21.85 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 2 columns):
Dividend Growth          40517 non-null float64
Dividend Payout Ratio    39947 non-null float64
```

```
dtypes: float64(2)
memory usage: 1.2+ MB
```

1.1.9 Profitability

[31]:
```
class ProfitabilityFactors:

    @staticmethod
    def GrossProfitMargin(mask):
        """Gross Profit divided by Net Sales"""

        gross_profit = AnnualizedData([Fundamentals.gross_profit_asof_date,
                                       Fundamentals.gross_profit], mask=mask)
        sales = AnnualizedData([Fundamentals.total_revenue_asof_date,
                                Fundamentals.total_revenue], mask=mask)
        return gross_profit / sales

    @staticmethod
    def NetIncomeMargin(mask):
        """Net income divided by Net Sales"""

        net_income = AnnualizedData([Fundamentals.
 ↪net_income_income_statement_asof_date,
                                       Fundamentals.net_income_income_statement],␣
 ↪mask=mask)
        sales = AnnualizedData([Fundamentals.total_revenue_asof_date,
                                Fundamentals.total_revenue], mask=mask)
        return net_income / sales
```

[32]:
```
PROFITABIILTY_FACTORS = {
    'Gross Profit Margin': ProfitabilityFactors.GrossProfitMargin,
    'Net Income Margin': ProfitabilityFactors.NetIncomeMargin,
    'Return on Equity': Fundamentals.roe.latest,
    'Return on Assets': Fundamentals.roa.latest,
    'Return on Invested Capital': Fundamentals.roic.latest
}
```

[33]:
```
profitability_result, t = factor_pipeline(PAYOUT_FACTORS)
print('Pipeline run time {:.2f} secs'.format(t))
payout_result.info()
```

```
Pipeline run time 21.65 secs
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 2 columns):
Dividend Growth          40517 non-null float64
```

```
Dividend Payout Ratio    39947 non-null float64
dtypes: float64(2)
memory usage: 1.2+ MB
```

[34]:
```
# profitability_pipeline().show_graph(format='png')
```

1.1.10 Build Dataset

Get Returns

[165]:
```
lookahead = [1, 5, 10, 20]
returns = run_pipeline(Pipeline({'Returns{}D'.format(i):␣
↪Returns(inputs=[USEquityPricing.close],
                                          window_length=i+1, mask=UNIVERSE) for␣
↪i in lookahead},
                                screen=UNIVERSE),
                       start_date=START,
                       end_date=END)
return_cols = ['Returns{}D'.format(i) for i in lookahead]
returns.info()
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 50362 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 4 columns):
Returns10D    50362 non-null float64
Returns1D     50362 non-null float64
Returns20D    50360 non-null float64
Returns5D     50362 non-null float64
dtypes: float64(4)
memory usage: 1.9+ MB
```

[166]:
```
data = pd.concat([returns,
                  value_result,
                  momentum_result,
                  quality_result,
                  payout_result,
                  growth_result,
                  efficiency_result,
                  risk_result], axis=1).sortlevel()
data.index.names = ['date', 'asset']
```

[167]:
```
data['stock'] = data.index.get_level_values('asset').map(lambda x: x.asset_name)
```

Remove columns and rows with less than 80% of data availability

[168]:
```
rows_before, cols_before = data.shape
data = (data
```

```python
        .dropna(axis=1, thresh=int(len(data)*.8))
        .dropna(thresh=int(len(data.columns) * .8)))
data = data.fillna(data.median())
rows_after, cols_after = data.shape
print('{:,d} rows and {:,d} columns dropped'.format(rows_before-rows_after,␣
 ↪cols_before-cols_after))
```

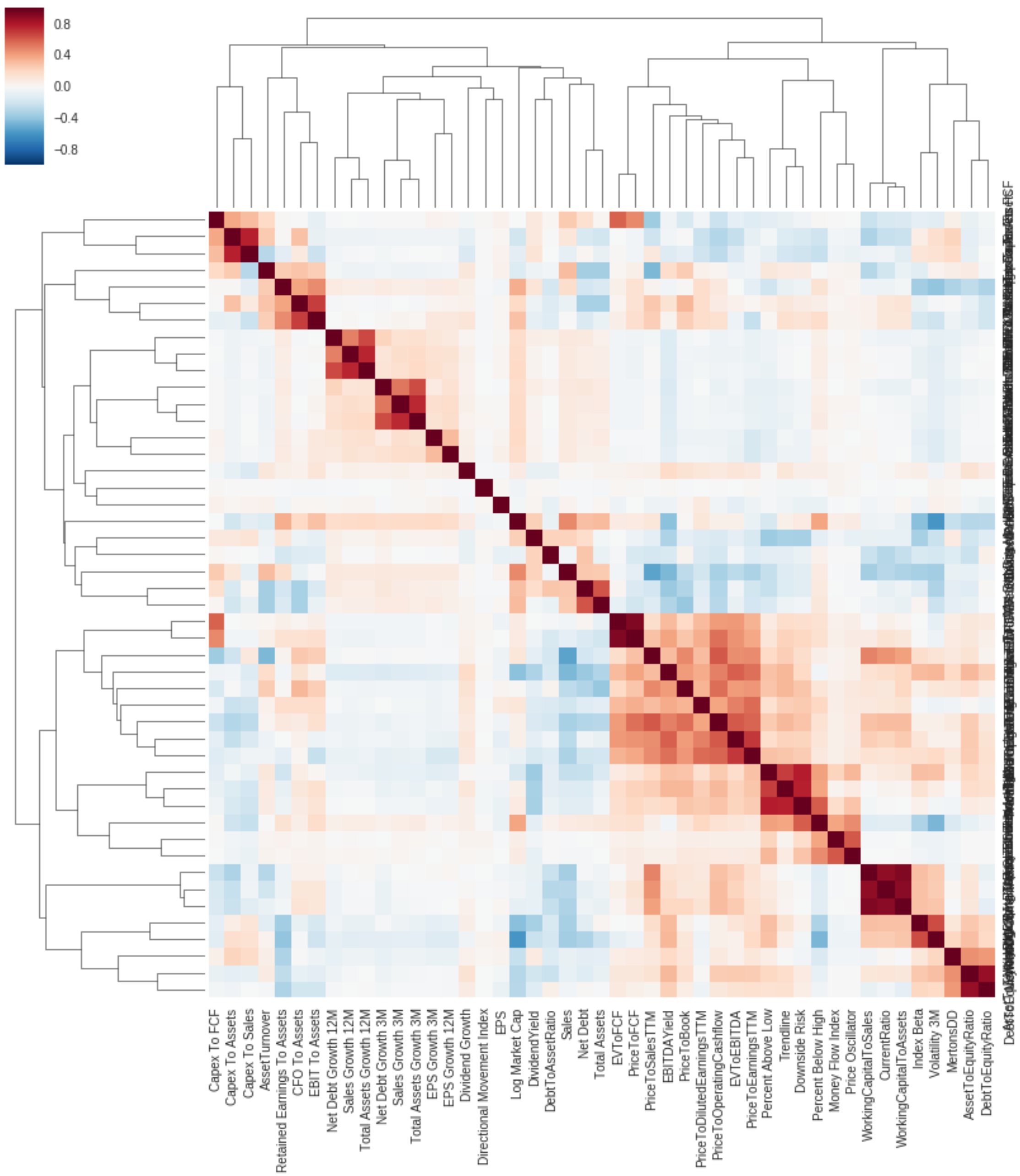
```
2,985 rows and 3 columns dropped
```

[169]:
```python
data.sort_index(1).info()
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 47377 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 52 columns):
AssetToEquityRatio             47377 non-null float64
AssetTurnover                  47377 non-null float64
CFO To Assets                  47377 non-null float64
Capex To Assets                47377 non-null float64
Capex To FCF                   47377 non-null float64
Capex To Sales                 47377 non-null float64
CurrentRatio                   47377 non-null float64
DebtToAssetRatio               47377 non-null float64
DebtToEquityRatio              47377 non-null float64
Directional Movement Index     47377 non-null float64
Dividend Growth                47377 non-null float64
DividendYield                  47377 non-null float64
Downside Risk                  47377 non-null float64
EBIT To Assets                 47377 non-null float64
EBITDAYield                    47377 non-null float64
EPS                            47377 non-null float64
EPS Growth 12M                 47377 non-null float64
EPS Growth 3M                  47377 non-null float64
EVToEBITDA                     47377 non-null float64
EVToFCF                        47377 non-null float64
Index Beta                     47377 non-null float64
Log Market Cap                 47377 non-null float64
MertonsDD                      47377 non-null float64
Money Flow Index               47377 non-null float64
Net Debt                       47377 non-null float64
Net Debt Growth 12M            47377 non-null float64
Net Debt Growth 3M             47377 non-null float64
Percent Above Low              47377 non-null float64
Percent Below High             47377 non-null float64
Price Oscillator               47377 non-null float64
PriceToBook                    47377 non-null float64
PriceToDilutedEarningsTTM      47377 non-null float64
PriceToEarningsTTM             47377 non-null float64
```

```
PriceToFCF                    47377 non-null float64
PriceToOperatingCashflow      47377 non-null float64
PriceToSalesTTM               47377 non-null float64
Retained Earnings To Assets   47377 non-null float64
Returns10D                    47377 non-null float64
Returns1D                     47377 non-null float64
Returns20D                    47377 non-null float64
Returns5D                     47377 non-null float64
Sales                         47377 non-null float64
Sales Growth 12M              47377 non-null float64
Sales Growth 3M               47377 non-null float64
Total Assets                  47377 non-null float64
Total Assets Growth 12M       47377 non-null float64
Total Assets Growth 3M        47377 non-null float64
Trendline                     47377 non-null float64
Volatility 3M                 47377 non-null float64
WorkingCapitalToAssets        47377 non-null float64
WorkingCapitalToSales         47377 non-null float64
stock                         47377 non-null object
dtypes: float64(51), object(1)
memory usage: 19.2+ MB
```

[170]:
```
g = sns.clustermap(data.drop(['stock'] + return_cols, axis=1).corr())
plt.gcf().set_size_inches((14,14));
```



Prepare Features

[171]:
```
X = pd.get_dummies(data.drop(return_cols, axis=1), drop_first=True)
X.info()
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 47377 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Columns: 182 entries, DividendYield to stock_YELP INC
```

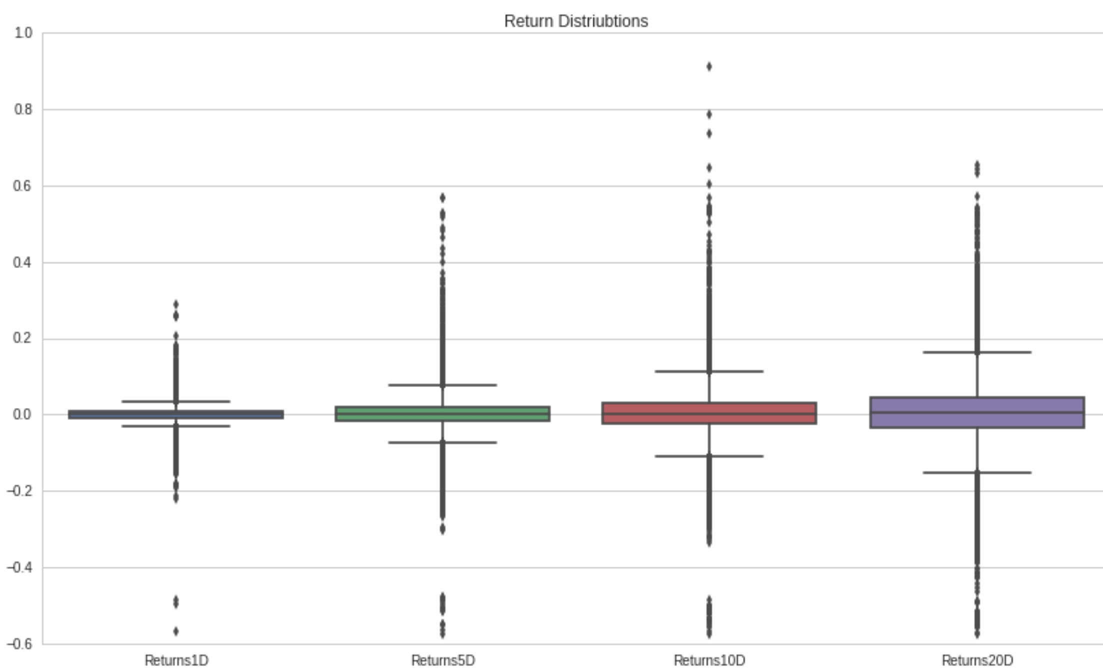
```
dtypes: float64(182)
memory usage: 66.1+ MB
```

Shifted Returns

[172]:
```
y = data.loc[:, return_cols]
shifted_y = []
for col in y.columns:
    t = int(re.search(r'\d+', col).group(0))
    shifted_y.append(y.groupby(level='asset')['Returns{}D'.format(t)].shift(-t).
 ↪to_frame(col))
y = pd.concat(shifted_y, axis=1)
y.info()
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 47377 entries, (2014-01-02 00:00:00+00:00, Equity(24 [AAPL])) to
(2015-12-31 00:00:00+00:00, Equity(47208 [GPRO]))
Data columns (total 4 columns):
Returns1D     47242 non-null float64
Returns5D     46706 non-null float64
Returns10D    46036 non-null float64
Returns20D    44696 non-null float64
dtypes: float64(4)
memory usage: 1.8+ MB
```

[175]:
```
ax = sns.boxplot(y[return_cols])
ax.set_title('Return Distriubtions');
```



1.1.11 Linear Regression

Statsmodels

[180]:
```
target = 'Returns1D'
model_data = pd.concat([y[[target]], X], axis=1).dropna()
model_data = model_data[model_data[target].between(model_data[target].quantile(.
↪025),
                                                    model_data[target].quantile(.
↪975))]

model = OLS(endog=model_data[target], exog=model_data.drop(target, axis=1))
trained_model = model.fit()
trained_model.summary()
```

[180]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:              Returns1D   R-squared:                       0.004
Model:                            OLS   Adj. R-squared:                  0.000
Method:                 Least Squares   F-statistic:                     1.084
Date:                Fri, 03 Aug 2018   Prob (F-statistic):              0.214
Time:                        21:40:26   Log-Likelihood:             1.3306e+05
No. Observations:               44878   AIC:                        -2.658e+05
Df Residuals:                   44703   BIC:                        -2.642e+05
Df Model:                         174
Covariance Type:            nonrobust
================================================================================
===============================
                                                  coef    std err          t
P>|t|      [95.0% Conf. Int.]
--------------------------------------------------------------------------------
-------------------------------
DividendYield                                1.249e-06     4.7e-07      2.659
0.008      3.28e-07  2.17e-06
EBITDAYield                                 -5.537e-06    9.48e-06     -0.584
0.559     -2.41e-05   1.3e-05
EVToEBITDA                                    4.87e-06     8.7e-06      0.560
0.575     -1.22e-05  2.19e-05
EVToFCF                                      3.621e-06    1.08e-05      0.334
0.738     -1.76e-05  2.48e-05
PriceToBook                                 -5.411e-07    1.03e-05     -0.052
0.958     -2.08e-05  1.97e-05
PriceToDilutedEarningsTTM                    4.561e-06    4.64e-06      0.983
0.326     -4.54e-06  1.37e-05
```

PriceToEarningsTTM	6e-08	2.05e-07	0.293	0.770	-3.41e-07	4.61e-07
PriceToFCF	-9.612e-07	9.07e-06	-0.106	0.916	-1.87e-05	1.68e-05
PriceToOperatingCashflow	-6.258e-07	6.16e-06	-0.102	0.919	-1.27e-05	1.14e-05
PriceToSalesTTM	-2.088e-06	5.16e-07	-4.048	0.000	-3.1e-06	-1.08e-06
Directional Movement Index	-3.169e-07	2.09e-06	-0.152	0.879	-4.4e-06	3.77e-06
Money Flow Index	-2.768e-06	2.7e-06	-1.025	0.305	-8.06e-06	2.52e-06
Percent Above Low	2.875e-06	5.17e-06	0.556	0.578	-7.26e-06	1.3e-05
Percent Below High	-1.786e-06	4.14e-06	-0.431	0.666	-9.9e-06	6.33e-06
Price Oscillator	9.18e-07	2.92e-06	0.314	0.753	-4.81e-06	6.64e-06
Trendline	2.007e-06	4.41e-06	0.455	0.649	-6.64e-06	1.07e-05
AssetToEquityRatio	5.633e-07	3.98e-07	1.414	0.157	-2.17e-07	1.34e-06
AssetTurnover	-1.27e-05	1.74e-05	-0.731	0.465	-4.68e-05	2.14e-05
CurrentRatio	3.246e-07	5.2e-07	0.625	0.532	-6.94e-07	1.34e-06
DebtToAssetRatio	5.697e-07	3.18e-07	1.792	0.073	-5.35e-08	1.19e-06
DebtToEquityRatio	-5.451e-07	3.69e-07	-1.476	0.140	-1.27e-06	1.79e-07
MertonsDD	-0.0001	4.64e-05	-2.661	0.008	-0.000	-3.25e-05
WorkingCapitalToAssets	1.452e-07	6.31e-07	0.230	0.818	-1.09e-06	1.38e-06
WorkingCapitalToSales	-2.24e-05	2.03e-05	-1.106	0.269	-6.21e-05	1.73e-05
Dividend Growth	-1.505e-08	1.96e-07	-0.077	0.939	-4e-07	3.69e-07
EPS	-1.219e-07	3.1e-07	-0.393	0.694	-7.3e-07	4.86e-07
Net Debt	-1.968e-14	1.12e-14	-1.760	0.078	-4.16e-14	2.23e-15
Sales	5.85e-15	1.04e-14	0.563	0.574	-1.45e-14	2.62e-14
Total Assets	-1.665e-14	7.87e-15	-2.116	0.034	-3.21e-14	-1.23e-15
EPS Growth 3M	-5.625e-08	4.75e-07	-0.118			

				0.906	-9.87e-07	8.75e-07
EPS Growth 12M	6.686e-07	4.76e-07	1.405	0.160	-2.64e-07	1.6e-06
Net Debt Growth 3M	8.433e-08	6.03e-07	0.140	0.889	-1.1e-06	1.27e-06
Net Debt Growth 12M	4.558e-07	6.14e-07	0.743	0.458	-7.47e-07	1.66e-06
Sales Growth 3M	2.469e-07	6.4e-07	0.386	0.699	-1.01e-06	1.5e-06
Sales Growth 12M	-4.861e-07	6.53e-07	-0.745	0.456	-1.77e-06	7.93e-07
Total Assets Growth 3M	4.535e-07	7.16e-07	0.633	0.527	-9.5e-07	1.86e-06
Total Assets Growth 12M	-3.477e-07	7.64e-07	-0.455	0.649	-1.84e-06	1.15e-06
CFO To Assets	1.731e-05	8.66e-06	1.999	0.046	3.36e-07	3.43e-05
Capex To Assets	-2.097e-05	1.87e-05	-1.124	0.261	-5.75e-05	1.56e-05
Capex To FCF	1.29e-06	1.05e-05	0.123	0.902	-1.92e-05	2.18e-05
Capex To Sales	1.637e-05	2e-05	0.820	0.412	-2.28e-05	5.55e-05
EBIT To Assets	7.612e-06	8.75e-06	0.870	0.385	-9.55e-06	2.48e-05
Retained Earnings To Assets	-3.547e-05	1.84e-05	-1.923	0.054	-7.16e-05	6.76e-07
Downside Risk	4.943e-07	5.32e-06	0.093	0.926	-9.93e-06	1.09e-05
Index Beta	-8.585e-08	1.09e-07	-0.786	0.432	-3e-07	1.28e-07
Log Market Cap	1.847e-05	1.86e-05	0.995	0.320	-1.79e-05	5.49e-05
Volatility 3M	-8.138e-06	4.53e-06	-1.798	0.072	-1.7e-05	7.33e-07
stock_3D SYSTEMS CORP	0.0157	0.004	3.600	0.000	0.007	0.024
stock_3M COMPANY	0.0108	0.004	2.823	0.005	0.003	0.018
stock_ABBOTT LABORATORIES	0.0069	0.003	2.315	0.021	0.001	0.013
stock_ABBVIE INC	0.0163	0.006	2.916	0.004	0.005	0.027
stock_ALLERGAN INC	0.0103	0.003	3.563	0.000	0.005	0.016
stock_ALLERGAN PLC	0.0135	0.004	3.310	0.001	0.006	0.022

```
stock_ALTABA INC                                    0.0161      0.005      3.560
0.000         0.007     0.025
stock_ALTRIA GROUP INC.                             0.0111      0.004      2.847
0.004         0.003     0.019
stock_AMAZON.COM INC                                0.0123      0.005      2.683
0.007         0.003     0.021
stock_AMERICAN AIRLINES GROUP INC                   0.0143      0.005      2.720
0.007         0.004     0.025
stock_AMERICAN EXPRESS COMPANY                      0.0065      0.002      2.656
0.008         0.002     0.011
stock_AMERICAN INTL GROUP INC                       0.0118      0.004      2.850
0.004         0.004     0.020
stock_AMGEN INC                                     0.0064      0.003      2.421
0.015         0.001     0.012
stock_ANADARKO PETROLEUM CORP                       0.0077      0.002      3.231
0.001         0.003     0.012
stock_APACHE CORP                                   0.0045      0.004      1.262
0.207        -0.003     0.012
stock_APPLE INC                                     0.0086      0.004      2.278
0.023         0.001     0.016
stock_APPLIED MATERIALS INC                         0.0075      0.003      2.572
0.010         0.002     0.013
stock_ARCONIC INC                                   0.0026      0.002      1.210
0.226        -0.002     0.007
stock_AT&T INC. COM                                 0.0103      0.004      2.420
0.016         0.002     0.019
stock_Alphabet Inc. Cl A                            0.0192      0.005      3.528
0.000         0.009     0.030
stock_BAKER HUGHES INC                              0.0078      0.003      2.946
0.003         0.003     0.013
stock_BANK OF AMERICA CORP                          0.0404      0.016      2.532
0.011         0.009     0.072
stock_BERKSHIRE HATHAWAY INC CL-B                   0.0171      0.006      3.069
0.002         0.006     0.028
stock_BIOGEN INC                                    0.0120      0.004      3.275
0.001         0.005     0.019
stock_BOEING CO                                     0.0053      0.003      1.864
0.062        -0.000     0.011
stock_BOOKING HOLDINGS INC                          0.0153      0.005      3.232
0.001         0.006     0.025
stock_BRISTOL MYERS SQUIBB COMPANY                  0.0097      0.003      3.001
0.003         0.003     0.016
stock_BROADCOM CORP                                 0.0134      0.004      3.087
0.002         0.005     0.022
stock_BROADCOM INC                                  0.0173      0.006      3.112
0.002         0.006     0.028
stock_CATERPILLAR INC                               0.0042      0.003      1.502
```

				0.133	-0.001	0.010
stock_CELGENE CORP	0.0091	0.003	2.905	0.004	0.003	0.015
stock_CHESAPEAKE ENERGY CORP	0.0041	0.005	0.874	0.382	-0.005	0.013
stock_CHEVRON CORPORATION	0.0137	0.006	2.386	0.017	0.002	0.025
stock_CISCO SYSTEMS INC	0.0066	0.003	2.363	0.018	0.001	0.012
stock_CITIGROUP	0.0371	0.014	2.713	0.007	0.010	0.064
stock_COCA-COLA CO	0.0101	0.004	2.629	0.009	0.003	0.018
stock_COMCAST CORP	0.0081	0.003	2.917	0.004	0.003	0.013
stock_CONOCOPHILLIPS	0.0125	0.005	2.566	0.010	0.003	0.022
stock_COVIDIEN PLC	0.0196	0.005	3.839	0.000	0.010	0.030
stock_CVS HEALTH CORP	0.0077	0.004	2.122	0.034	0.001	0.015
stock_DEERE & CO	0.0050	0.003	1.671	0.095	-0.001	0.011
stock_DELTA AIR LINES INC	0.0141	0.005	2.882	0.004	0.005	0.024
stock_DIRECTV	0.0114	0.005	2.405	0.016	0.002	0.021
stock_DOLLAR GENERAL CORP	0.0143	0.005	2.899	0.004	0.005	0.024
stock_DOW CHEMICAL CO	0.0055	0.003	1.960	0.050	-5.93e-07	0.011
stock_E.I. Du Pont De Nemours A	0.0060	0.003	2.109	0.035	0.000	0.012
stock_EBAY INC	0.0166	0.005	3.281	0.001	0.007	0.027
stock_EMC CORPORATION	0.0082	0.003	2.886	0.004	0.003	0.014
stock_EOG RESOURCES INC	0.0099	0.003	3.577	0.000	0.004	0.015
stock_EXPRESS SCRIPTS HOLDING CO	0.0034	0.003	1.166	0.244	-0.002	0.009
stock_EXXON MOBIL CORPORATION	0.0128	0.007	1.936	0.053	-0.000	0.026
stock_FACEBOOK INC	0.0199	0.006	3.452	0.001	0.009	0.031
stock_FEDEX CORPORATION	0.0079	0.003	2.618	0.009	0.002	0.014

stock_FIRST SOLAR INC	0.0180	0.005	3.411	0.001	0.008	0.028
stock_FORD MOTOR CO(NEW)	0.0057	0.004	1.626	0.104	-0.001	0.013
stock_FREEPORT-MCMORAN INC	0.0090	0.004	2.333	0.020	0.001	0.017
stock_GENERAL ELECTRIC CO	0.0165	0.005	3.025	0.002	0.006	0.027
stock_GENERAL MOTORS CO	0.0131	0.006	2.358	0.018	0.002	0.024
stock_GILEAD SCIENCES INC	0.0108	0.003	3.141	0.002	0.004	0.017
stock_GOLDMAN SACHS GROUP INC	0.0317	0.007	4.257	0.000	0.017	0.046
stock_GOPRO INC	0.0199	0.006	3.550	0.000	0.009	0.031
stock_HALLIBURTON CO (HOLDING CO)	0.0084	0.003	2.752	0.006	0.002	0.014
stock_HOME DEPOT INC	0.0070	0.003	2.052	0.040	0.000	0.014
stock_HP INC	0.0051	0.003	1.624	0.104	-0.001	0.011
stock_INTEL CORP	0.0087	0.003	2.535	0.011	0.002	0.015
stock_INTL BUSINESS MACHINES CORP	0.0087	0.004	2.280	0.023	0.001	0.016
stock_JOHNSON AND JOHNSON	0.0111	0.004	2.834	0.005	0.003	0.019
stock_JPMORGAN CHASE & CO COM STK	0.0545	0.019	2.818	0.005	0.017	0.092
stock_KEURIG GREEN MOUNTAIN INC	0.0146	0.004	3.591	0.000	0.007	0.023
stock_KINDER MORGAN INC	0.0132	0.005	2.470	0.014	0.003	0.024
stock_LAS VEGAS SANDS CORP	0.0127	0.005	2.488	0.013	0.003	0.023
stock_LILLY ELI & CO	0.0102	0.004	2.885	0.004	0.003	0.017
stock_LINKEDIN CORP	0.0197	0.006	3.505	0.000	0.009	0.031
stock_LOWES COMPANIES INC	0.0075	0.003	2.483	0.013	0.002	0.013
stock_LYONDELLBASELL INDUSTRIES NV	0.0135	0.005	2.593	0.010	0.003	0.024
stock_MARATHON PETROLEUM CORP	0.0128	0.006	2.268	0.023	0.002	0.024
stock_MASTERCARD INCORPORATED	0.0206	0.006	3.731			

```
0.000         0.010     0.031
stock_MCDONALDS CORP                              0.0099      0.004      2.513
0.012         0.002     0.018
stock_MEDTRONIC PLC                               0.0119      0.004      3.390
0.001         0.005     0.019
stock_MERCK & CO INC                              0.0110      0.004      2.966
0.003         0.004     0.018
stock_METLIFE  INC                                0.0260      0.008      3.353
0.001         0.011     0.041
stock_MICHAEL KORS HOLDINGS LTD                   0.0214      0.006      3.646
0.000         0.010     0.033
stock_MICRON TECHNOLOGY INC                       0.0102      0.003      3.287
0.001         0.004     0.016
stock_MICROSOFT CORP                              0.0115      0.004      3.028
0.002         0.004     0.019
stock_MONDELEZ INTERNATIONAL INC                  0.0133      0.005      2.875
0.004         0.004     0.022
stock_MONSANTO COMPANY                            0.0153      0.005      3.201
0.001         0.006     0.025
stock_MORGAN STANLEY                              0.0273      0.007      3.884
0.000         0.014     0.041
stock_MYLAN NV                                    0.0111      0.003      3.260
0.001         0.004     0.018
stock_NATIONAL OILWELL VARCO  INC.                0.0131      0.005      2.642
0.008         0.003     0.023
stock_NETFLIX INC                                 0.0179      0.005      3.555
0.000         0.008     0.028
stock_NEWMONT MINING CORP (HOLDING COMPANY)       0.0098      0.004      2.773
0.006         0.003     0.017
stock_NEWS CP - CL A                              0.0129      0.004      3.348
0.001         0.005     0.020
stock_NIKE INC CL-B                               0.0104      0.004      2.884
0.004         0.003     0.018
stock_OCCIDENTAL PETROLEUM CORP                   0.0118      0.004      3.153
0.002         0.004     0.019
stock_ORACLE CORP                                 0.0118      0.004      3.297
0.001         0.005     0.019
stock_PANDORA MEDIA INC                           0.0235      0.006      3.942
0.000         0.012     0.035
stock_PENNEY J.C. CO INC (HOLDING COMPANY)        0.0027      0.003      0.905
0.365        -0.003     0.009
stock_PEPSICO INC                                 0.0104      0.004      2.533
0.011         0.002     0.018
stock_PFIZER INC                                  0.0134      0.004      3.287
0.001         0.005     0.021
stock_PHILIP MORRIS INTERNATIONAL INC             0.0154      0.006      2.576
0.010         0.004     0.027
```

```
stock_PIONEER NAT RES CO                          0.0177      0.004      4.022
0.000          0.009     0.026
stock_PRECISION CASTPARTS CORP                    0.0145      0.004      3.574
0.000          0.007     0.022
stock_PROCTER & GAMBLE CO                         0.0115      0.004      2.722
0.006          0.003     0.020
stock_QUALCOMM INC                                0.0131      0.004      3.223
0.001          0.005     0.021
stock_REGENERON PHARMACEUTICALS INC               0.0117      0.005      2.380
0.017          0.002     0.021
stock_SALESFORCE.COM INC                          0.0173      0.005      3.443
0.001          0.007     0.027
stock_SALIX PHARMACEUTICALS LTD               -2.111e-18   7.34e-17     -0.029
0.977     -1.46e-16  1.42e-16
stock_SANDISK CORP                                0.0154      0.004      3.629
0.000          0.007     0.024
stock_SCHLUMBERGER LTD.                           0.0120      0.004      3.003
0.003          0.004     0.020
stock_SKYWORKS SOLUTIONS INC                      0.0191      0.005      3.796
0.000          0.009     0.029
stock_SOLARCITY CORP                              0.0208      0.006      3.549
0.000          0.009     0.032
stock_SOUTHWEST AIRLINES CO                       0.0092      0.003      2.885
0.004          0.003     0.015
stock_STARBUCKS CORPORATION                       0.0147      0.004      3.658
0.000          0.007     0.023
stock_SUNEDISON INC                               0.0183      0.006      3.237
0.001          0.007     0.029
stock_TARGET CORPORATION                          0.0104      0.004      2.349
0.019          0.002     0.019
stock_TESLA INC                                   0.0196      0.006      3.520
0.000          0.009     0.031
stock_TEXAS INSTRUMENTS INC                       0.0141      0.004      3.229
0.001          0.006     0.023
stock_TIME WARNER CABLE INC                       0.0140      0.005      2.883
0.004          0.004     0.024
stock_TIME WARNER INC.                            0.0049      0.002      2.324
0.020          0.001     0.009
stock_TWITTER INC                                 0.0185      0.006      3.201
0.001          0.007     0.030
stock_UNION PACIFIC CORPORATION                   0.0130      0.004      3.275
0.001          0.005     0.021
stock_UNITED CONTINENTAL HOLDINGS IN              0.0097      0.005      2.019
0.044          0.000     0.019
stock_UNITED PARCEL SERVICE INC.CL B              0.0101      0.005      2.184
0.029          0.001     0.019
stock_UNITED TECHNOLOGIES CORP                    0.0113      0.004      2.830
```

```
0.005          0.003     0.019
stock_UNITEDHEALTH GROUP INC                      0.0100      0.004      2.453
0.014          0.002     0.018
stock_VALERO ENERGY CORP (NEW)                    0.0099      0.004      2.405
0.016          0.002     0.018
stock_VERIZON COMMUNICATIONS                      0.0116      0.005      2.369
0.018          0.002     0.021
stock_VISA INC                                    0.0189      0.005      3.588
0.000          0.009     0.029
stock_WALGREENS BOOTS ALLIANCE INC                0.0109      0.004      2.732
0.006          0.003     0.019
stock_WALMART INC                                 0.0078      0.006      1.208
0.227         -0.005     0.020
stock_WALT DISNEY CO                              0.0102      0.003      3.309
0.001          0.004     0.016
stock_WELLS FARGO & CO(NEW)                       0.0434      0.013      3.348
0.001          0.018     0.069
stock_WILLIAMS COMPANIES                          0.0109      0.004      2.720
0.007          0.003     0.019
stock_WYNN RESORTS LTD                            0.0109      0.005      2.254
0.024          0.001     0.020
stock_YELP INC                                    0.0231      0.006      3.978
0.000          0.012     0.034
==============================================================================
Omnibus:                       41.371   Durbin-Watson:                   1.329
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               45.849
Skew:                          -0.034   Prob(JB):                     1.11e-10
Kurtosis:                       3.141   Cond. No.                     5.40e+21
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 1.4e-16. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

[184]:

```
target = 'Returns5D'
model_data = pd.concat([y[[target]], X], axis=1).dropna()
model_data = model_data[model_data[target].between(model_data[target].quantile(.
 ↪025),
                                                    model_data[target].quantile(.
 ↪975))]

model = OLS(endog=model_data[target], exog=model_data.drop(target, axis=1))
trained_model = model.fit()
trained_model.summary()
```

[184]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:              Returns5D   R-squared:                       0.016
Model:                            OLS   Adj. R-squared:                  0.012
Method:                 Least Squares   F-statistic:                     4.124
Date:                Fri, 03 Aug 2018   Prob (F-statistic):           2.28e-66
Time:                        21:41:14   Log-Likelihood:                 95279.
No. Observations:               44370   AIC:                        -1.902e+05
Df Residuals:                   44195   BIC:                        -1.887e+05
Df Model:                         174
Covariance Type:            nonrobust
================================================================================
===============================
                                                  coef    std err          t
P>|t|      [95.0% Conf. Int.]
--------------------------------------------------------------------------------
-------------------------------
DividendYield                                4.504e-06   1.08e-06      4.185
0.000       2.39e-06  6.61e-06
EBITDAYield                                  9.323e-06   2.17e-05      0.430
0.667     -3.32e-05  5.19e-05
EVToEBITDA                                   1.425e-05   1.98e-05      0.719
0.472     -2.46e-05  5.31e-05
EVToFCF                                      2.654e-05   2.47e-05      1.075
0.283     -2.19e-05  7.49e-05
PriceToBook                                  1.582e-05   2.36e-05      0.669
0.503     -3.05e-05  6.21e-05
PriceToDilutedEarningsTTM                    5.462e-07   1.06e-05      0.052
0.959     -2.01e-05  2.12e-05
PriceToEarningsTTM                           1.449e-07   4.67e-07      0.310
0.757     -7.71e-07  1.06e-06
PriceToFCF                                   -1.94e-05   2.07e-05     -0.939
0.348     -5.99e-05  2.11e-05
PriceToOperatingCashflow                    -4.155e-05   1.42e-05     -2.934
0.003     -6.93e-05 -1.38e-05
PriceToSalesTTM                             -8.975e-06   1.19e-06     -7.530
0.000     -1.13e-05 -6.64e-06
Directional Movement Index                  -4.457e-06   4.75e-06     -0.938
0.348     -1.38e-05  4.86e-06
Money Flow Index                            -5.894e-06   6.16e-06     -0.956
0.339      -1.8e-05  6.19e-06
Percent Above Low                           -1.985e-05   1.18e-05     -1.675
0.094     -4.31e-05  3.38e-06
Percent Below High                           7.651e-06   9.42e-06      0.812
0.417     -1.08e-05  2.61e-05
```

Price Oscillator	3.706e-06	6.64e-06	0.558	0.577	-9.31e-06	1.67e-05
Trendline	1.414e-05	1.01e-05	1.402	0.161	-5.64e-06	3.39e-05
AssetToEquityRatio	-1.226e-07	8.91e-07	-0.138	0.891	-1.87e-06	1.62e-06
AssetTurnover	-7.3e-06	3.95e-05	-0.185	0.854	-8.48e-05	7.02e-05
CurrentRatio	4.11e-07	1.18e-06	0.347	0.728	-1.91e-06	2.73e-06
DebtToAssetRatio	2.484e-06	7.25e-07	3.427	0.001	1.06e-06	3.9e-06
DebtToEquityRatio	-5.365e-07	8.37e-07	-0.641	0.521	-2.18e-06	1.1e-06
MertonsDD	-0.0004	0.000	-3.508	0.000	-0.001	-0.000
WorkingCapitalToAssets	1.341e-06	1.44e-06	0.932	0.351	-1.48e-06	4.16e-06
WorkingCapitalToSales	-3.118e-05	4.62e-05	-0.674	0.500	-0.000	5.95e-05
Dividend Growth	-2.629e-07	4.5e-07	-0.585	0.559	-1.14e-06	6.18e-07
EPS	2.901e-07	7.04e-07	0.412	0.680	-1.09e-06	1.67e-06
Net Debt	-8.116e-14	2.56e-14	-3.172	0.002	-1.31e-13	-3.1e-14
Sales	-5.373e-14	2.4e-14	-2.239	0.025	-1.01e-13	-6.69e-15
Total Assets	-4.104e-14	1.8e-14	-2.276	0.023	-7.64e-14	-5.7e-15
EPS Growth 3M	-2.787e-06	1.08e-06	-2.582	0.010	-4.9e-06	-6.72e-07
EPS Growth 12M	1.257e-06	1.08e-06	1.161	0.246	-8.64e-07	3.38e-06
Net Debt Growth 3M	2.628e-07	1.37e-06	0.191	0.848	-2.43e-06	2.95e-06
Net Debt Growth 12M	2.592e-06	1.4e-06	1.858	0.063	-1.43e-07	5.33e-06
Sales Growth 3M	3.824e-06	1.45e-06	2.634	0.008	9.79e-07	6.67e-06
Sales Growth 12M	-2.38e-06	1.48e-06	-1.604	0.109	-5.29e-06	5.28e-07
Total Assets Growth 3M	-6.292e-07	1.63e-06	-0.386	0.699	-3.82e-06	2.56e-06
Total Assets Growth 12M	-1.46e-06	1.73e-06	-0.842	0.400	-4.86e-06	1.94e-06
CFO To Assets	4.634e-05	1.98e-05	2.342			

```
0.019      7.56e-06  8.51e-05
Capex To Assets                                   -0.0001   4.26e-05     -3.232
0.001        -0.000 -5.42e-05
Capex To FCF                                    3.673e-05   2.39e-05      1.534
0.125     -1.02e-05  8.37e-05
Capex To Sales                                     0.0001   4.56e-05      2.247
0.025      1.31e-05     0.000
EBIT To Assets                                  8.146e-06      2e-05      0.408
0.683      -3.1e-05  4.73e-05
Retained Earnings To Assets                       -0.0001    4.2e-05     -3.036
0.002        -0.000 -4.51e-05
Downside Risk                                   1.166e-05   1.22e-05      0.960
0.337     -1.22e-05  3.55e-05
Index Beta                                     -7.363e-07   2.49e-07     -2.958
0.003     -1.22e-06 -2.48e-07
Log Market Cap                                  9.103e-05   4.24e-05      2.148
0.032      7.98e-06     0.000
Volatility 3M                                  -5.492e-05   1.04e-05     -5.306
0.000     -7.52e-05 -3.46e-05
stock_3D SYSTEMS CORP                              0.0568      0.010      5.697
0.000         0.037     0.076
stock_3M COMPANY                                   0.0426      0.009      4.865
0.000         0.025     0.060
stock_ABBOTT LABORATORIES                          0.0264      0.007      3.854
0.000         0.013     0.040
stock_ABBVIE INC                                   0.0572      0.013      4.482
0.000         0.032     0.082
stock_ALLERGAN INC                                 0.0487      0.007      7.349
0.000         0.036     0.062
stock_ALLERGAN PLC                                 0.0543      0.009      5.812
0.000         0.036     0.073
stock_ALTABA INC                                   0.0605      0.010      5.857
0.000         0.040     0.081
stock_ALTRIA GROUP INC.                            0.0453      0.009      5.074
0.000         0.028     0.063
stock_AMAZON.COM INC                               0.0513      0.010      4.905
0.000         0.031     0.072
stock_AMERICAN AIRLINES GROUP INC                  0.0490      0.012      4.079
0.000         0.025     0.073
stock_AMERICAN EXPRESS COMPANY                     0.0232      0.006      4.177
0.000         0.012     0.034
stock_AMERICAN INTL GROUP INC                      0.0452      0.009      4.770
0.000         0.027     0.064
stock_AMGEN INC                                    0.0266      0.006      4.400
0.000         0.015     0.038
stock_ANADARKO PETROLEUM CORP                      0.0347      0.005      6.387
0.000         0.024     0.045
```

```
stock_APACHE CORP                                0.0130     0.009     1.487
0.137       -0.004     0.030
stock_APPLE INC                                  0.0471     0.009     5.478
0.000        0.030     0.064
stock_APPLIED MATERIALS INC                      0.0333     0.007     4.965
0.000        0.020     0.046
stock_ARCONIC INC                                0.0090     0.005     1.822
0.068       -0.001     0.019
stock_AT&T INC. COM                              0.0372     0.010     3.817
0.000        0.018     0.056
stock_Alphabet Inc. Cl A                         0.0713     0.012     5.733
0.000        0.047     0.096
stock_BAKER HUGHES INC                           0.0296     0.006     4.920
0.000        0.018     0.041
stock_BANK OF AMERICA CORP                       0.1209     0.037     3.306
0.001        0.049     0.193
stock_BERKSHIRE HATHAWAY INC CL-B                0.0629     0.013     4.939
0.000        0.038     0.088
stock_BIOGEN INC                                 0.0551     0.008     6.605
0.000        0.039     0.071
stock_BOEING CO                                  0.0230     0.007     3.524
0.000        0.010     0.036
stock_BOOKING HOLDINGS INC                       0.0600     0.011     5.539
0.000        0.039     0.081
stock_BRISTOL MYERS SQUIBB COMPANY               0.0405     0.007     5.456
0.000        0.026     0.055
stock_BROADCOM CORP                              0.0564     0.010     5.697
0.000        0.037     0.076
stock_BROADCOM INC                               0.0733     0.013     5.818
0.000        0.049     0.098
stock_CATERPILLAR INC                            0.0139     0.006     2.172
0.030        0.001     0.027
stock_CELGENE CORP                               0.0385     0.007     5.398
0.000        0.025     0.053
stock_CHESAPEAKE ENERGY CORP                     0.0269     0.011     2.555
0.011        0.006     0.048
stock_CHEVRON CORPORATION                        0.0562     0.013     4.283
0.000        0.030     0.082
stock_CISCO SYSTEMS INC                          0.0285     0.006     4.464
0.000        0.016     0.041
stock_CITIGROUP                                  0.1090     0.031     3.474
0.001        0.048     0.171
stock_COCA-COLA CO                               0.0384     0.009     4.352
0.000        0.021     0.056
stock_COMCAST CORP                               0.0325     0.006     5.155
0.000        0.020     0.045
stock_CONOCOPHILLIPS                             0.0456     0.011     4.089
```

0.000	0.024	0.067			
stock_COVIDIEN PLC			0.0743	0.012	6.354
0.000	0.051	0.097			
stock_CVS HEALTH CORP			0.0358	0.008	4.345
0.000	0.020	0.052			
stock_DEERE & CO			0.0115	0.007	1.683
0.092	-0.002	0.025			
stock_DELTA AIR LINES INC			0.0545	0.011	4.896
0.000	0.033	0.076			
stock_DIRECTV			0.0383	0.011	3.558
0.000	0.017	0.059			
stock_DOLLAR GENERAL CORP			0.0508	0.011	4.509
0.000	0.029	0.073			
stock_DOW CHEMICAL CO			0.0234	0.006	3.686
0.000	0.011	0.036			
stock_E.I. Du Pont De Nemours A			0.0204	0.007	3.137
0.002	0.008	0.033			
stock_EBAY INC			0.0611	0.012	5.279
0.000	0.038	0.084			
stock_EMC CORPORATION			0.0341	0.007	5.245
0.000	0.021	0.047			
stock_EOG RESOURCES INC			0.0413	0.006	6.573
0.000	0.029	0.054			
stock_EXPRESS SCRIPTS HOLDING CO			0.0177	0.007	2.628
0.009	0.005	0.031			
stock_EXXON MOBIL CORPORATION			0.0677	0.015	4.484
0.000	0.038	0.097			
stock_FACEBOOK INC			0.0762	0.013	5.785
0.000	0.050	0.102			
stock_FEDEX CORPORATION			0.0321	0.007	4.657
0.000	0.019	0.046			
stock_FIRST SOLAR INC			0.0484	0.012	4.004
0.000	0.025	0.072			
stock_FORD MOTOR CO(NEW)			0.0213	0.008	2.647
0.008	0.006	0.037			
stock_FREEPORT-MCMORAN INC			0.0269	0.009	3.063
0.002	0.010	0.044			
stock_GENERAL ELECTRIC CO			0.0556	0.013	4.444
0.000	0.031	0.080			
stock_GENERAL MOTORS CO			0.0485	0.013	3.829
0.000	0.024	0.073			
stock_GILEAD SCIENCES INC			0.0459	0.008	5.868
0.000	0.031	0.061			
stock_GOLDMAN SACHS GROUP INC			0.0965	0.017	5.644
0.000	0.063	0.130			
stock_GOPRO INC			0.0687	0.013	5.377
0.000	0.044	0.094			

stock_HALLIBURTON CO (HOLDING CO)	0.0322	0.007	4.601	0.000	0.018	0.046
stock_HOME DEPOT INC	0.0336	0.008	4.320	0.000	0.018	0.049
stock_HP INC	0.0254	0.007	3.507	0.000	0.011	0.040
stock_INTEL CORP	0.0383	0.008	4.891	0.000	0.023	0.054
stock_INTL BUSINESS MACHINES CORP	0.0329	0.009	3.784	0.000	0.016	0.050
stock_JOHNSON AND JOHNSON	0.0431	0.009	4.833	0.000	0.026	0.061
stock_JPMORGAN CHASE & CO COM STK	0.1531	0.044	3.455	0.001	0.066	0.240
stock_KEURIG GREEN MOUNTAIN INC	0.0569	0.009	6.135	0.000	0.039	0.075
stock_KINDER MORGAN INC	0.0427	0.012	3.497	0.000	0.019	0.067
stock_LAS VEGAS SANDS CORP	0.0494	0.012	4.235	0.000	0.027	0.072
stock_LILLY ELI & CO	0.0411	0.008	5.097	0.000	0.025	0.057
stock_LINKEDIN CORP	0.0700	0.013	5.460	0.000	0.045	0.095
stock_LOWES COMPANIES INC	0.0307	0.007	4.474	0.000	0.017	0.044
stock_LYONDELLBASELL INDUSTRIES NV	0.0478	0.012	4.043	0.000	0.025	0.071
stock_MARATHON PETROLEUM CORP	0.0508	0.013	3.939	0.000	0.026	0.076
stock_MASTERCARD INCORPORATED	0.0778	0.013	6.157	0.000	0.053	0.103
stock_MCDONALDS CORP	0.0380	0.009	4.236	0.000	0.020	0.056
stock_MEDTRONIC PLC	0.0482	0.008	6.017	0.000	0.033	0.064
stock_MERCK & CO INC	0.0425	0.008	5.002	0.000	0.026	0.059
stock_METLIFE INC	0.0738	0.018	4.162	0.000	0.039	0.109
stock_MICHAEL KORS HOLDINGS LTD	0.0770	0.013	5.750	0.000	0.051	0.103
stock_MICRON TECHNOLOGY INC	0.0363	0.007	5.112	0.000	0.022	0.050
stock_MICROSOFT CORP	0.0468	0.009	5.410	0.000	0.030	0.064
stock_MONDELEZ INTERNATIONAL INC	0.0519	0.011	4.934			

```
0.000         0.031     0.073
stock_MONSANTO COMPANY                          0.0556      0.011      5.111
0.000         0.034     0.077
stock_MORGAN STANLEY                            0.0829      0.016      5.139
0.000         0.051     0.115
stock_MYLAN NV                                  0.0430      0.008      5.515
0.000         0.028     0.058
stock_NATIONAL OILWELL VARCO  INC.              0.0397      0.011      3.525
0.000         0.018     0.062
stock_NETFLIX INC                               0.0690      0.011      6.016
0.000         0.047     0.092
stock_NEWMONT MINING CORP (HOLDING COMPANY)     0.0312      0.008      3.782
0.000         0.015     0.047
stock_NEWS CP - CL A                            0.0462      0.009      5.253
0.000         0.029     0.063
stock_NIKE INC CL-B                             0.0466      0.008      5.636
0.000         0.030     0.063
stock_OCCIDENTAL PETROLEUM CORP                 0.0420      0.009      4.899
0.000         0.025     0.059
stock_ORACLE CORP                               0.0434      0.008      5.331
0.000         0.027     0.059
stock_PANDORA MEDIA INC                         0.0953      0.014      6.986
0.000         0.069     0.122
stock_PENNEY J.C. CO INC (HOLDING COMPANY)      0.0163      0.007      2.353
0.019         0.003     0.030
stock_PEPSICO INC                               0.0387      0.009      4.139
0.000         0.020     0.057
stock_PFIZER INC                                0.0498      0.009      5.350
0.000         0.032     0.068
stock_PHILIP MORRIS INTERNATIONAL INC           0.0577      0.014      4.236
0.000         0.031     0.084
stock_PIONEER NAT RES CO                        0.0716      0.010      7.136
0.000         0.052     0.091
stock_PRECISION CASTPARTS CORP                  0.0510      0.009      5.448
0.000         0.033     0.069
stock_PROCTER & GAMBLE CO                       0.0442      0.010      4.581
0.000         0.025     0.063
stock_QUALCOMM INC                              0.0532      0.009      5.739
0.000         0.035     0.071
stock_REGENERON PHARMACEUTICALS INC             0.0537      0.011      4.675
0.000         0.031     0.076
stock_SALESFORCE.COM INC                        0.0610      0.011      5.303
0.000         0.038     0.083
stock_SALIX PHARMACEUTICALS LTD              -4.65e-16   2.62e-15     -0.178
0.859      -5.6e-15  4.67e-15
stock_SANDISK CORP                              0.0624      0.010      6.426
0.000         0.043     0.081
```

stock_SCHLUMBERGER LTD.	0.0441	0.009	4.843	0.000	0.026	0.062
stock_SKYWORKS SOLUTIONS INC	0.0772	0.011	6.749	0.000	0.055	0.100
stock_SOLARCITY CORP	0.0820	0.013	6.129	0.000	0.056	0.108
stock_SOUTHWEST AIRLINES CO	0.0430	0.007	5.909	0.000	0.029	0.057
stock_STARBUCKS CORPORATION	0.0606	0.009	6.590	0.000	0.043	0.079
stock_SUNEDISON INC	0.0234	0.017	1.401	0.161	-0.009	0.056
stock_TARGET CORPORATION	0.0356	0.010	3.541	0.000	0.016	0.055
stock_TESLA INC	0.0720	0.013	5.659	0.000	0.047	0.097
stock_TEXAS INSTRUMENTS INC	0.0522	0.010	5.206	0.000	0.033	0.072
stock_TIME WARNER CABLE INC	0.0468	0.011	4.218	0.000	0.025	0.069
stock_TIME WARNER INC.	0.0227	0.005	4.748	0.000	0.013	0.032
stock_TWITTER INC	0.0686	0.013	5.194	0.000	0.043	0.094
stock_UNION PACIFIC CORPORATION	0.0493	0.009	5.446	0.000	0.032	0.067
stock_UNITED CONTINENTAL HOLDINGS IN	0.0379	0.011	3.469	0.001	0.016	0.059
stock_UNITED PARCEL SERVICE INC.CL B	0.0366	0.011	3.462	0.001	0.016	0.057
stock_UNITED TECHNOLOGIES CORP	0.0390	0.009	4.277	0.000	0.021	0.057
stock_UNITEDHEALTH GROUP INC	0.0455	0.009	4.866	0.000	0.027	0.064
stock_VALERO ENERGY CORP (NEW)	0.0432	0.009	4.596	0.000	0.025	0.062
stock_VERIZON COMMUNICATIONS	0.0392	0.011	3.502	0.000	0.017	0.061
stock_VISA INC	0.0769	0.012	6.389	0.000	0.053	0.100
stock_WALGREENS BOOTS ALLIANCE INC	0.0444	0.009	4.859	0.000	0.026	0.062
stock_WALMART INC	0.0554	0.015	3.742	0.000	0.026	0.084
stock_WALT DISNEY CO	0.0432	0.007	6.119	0.000	0.029	0.057
stock_WELLS FARGO & CO(NEW)	0.1324	0.030	4.449			

```
0.000          0.074     0.191
stock_WILLIAMS COMPANIES                          0.0472      0.009      5.143
0.000          0.029     0.065
stock_WYNN RESORTS LTD                            0.0410      0.011      3.710
0.000          0.019     0.063
stock_YELP INC                                    0.0728      0.013      5.489
0.000          0.047     0.099
==============================================================================
Omnibus:                       71.266   Durbin-Watson:                   1.433
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               77.090
Skew:                          -0.067   Prob(JB):                     1.82e-17
Kurtosis:                       3.154   Cond. No.                     3.42e+20
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 3.44e-14. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

[185]:

```python
target = 'Returns10D'
model_data = pd.concat([y[[target]], X], axis=1).dropna()
model_data = model_data[model_data[target].between(model_data[target].quantile(.
 ↪025),
                                                    model_data[target].quantile(.
 ↪975))]

model = OLS(endog=model_data[target], exog=model_data.drop(target, axis=1))
trained_model = model.fit()
trained_model.summary()
```

[185]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:             Returns10D   R-squared:                       0.035
Model:                            OLS   Adj. R-squared:                  0.031
Method:                 Least Squares   F-statistic:                     9.045
Date:                Fri, 03 Aug 2018   Prob (F-statistic):          5.42e-219
Time:                        21:41:36   Log-Likelihood:                 78861.
No. Observations:               43734   AIC:                        -1.574e+05
Df Residuals:                   43559   BIC:                        -1.559e+05
Df Model:                         174
Covariance Type:            nonrobust
================================================================================
================================
```

	coef	std err	t	P>|t|	[95.0% Conf. Int.]	
DividendYield	6.757e-06	1.55e-06	4.370	0.000	3.73e-06	9.79e-06
EBITDAYield	-1.021e-05	3.11e-05	-0.329	0.743	-7.11e-05	5.07e-05
EVToEBITDA	9.163e-05	2.83e-05	3.233	0.001	3.61e-05	0.000
EVToFCF	2.372e-05	3.51e-05	0.676	0.499	-4.5e-05	9.25e-05
PriceToBook	8.448e-05	3.34e-05	2.533	0.011	1.91e-05	0.000
PriceToDilutedEarningsTTM	-1.332e-05	1.5e-05	-0.889	0.374	-4.27e-05	1.61e-05
PriceToEarningsTTM	-6.983e-07	6.67e-07	-1.047	0.295	-2e-06	6.08e-07
PriceToFCF	-4.525e-06	2.91e-05	-0.155	0.877	-6.16e-05	5.26e-05
PriceToOperatingCashflow	-8.243e-05	2.02e-05	-4.071	0.000	-0.000	-4.27e-05
PriceToSalesTTM	-2.324e-05	1.72e-06	-13.493	0.000	-2.66e-05	-1.99e-05
Directional Movement Index	-2.235e-05	6.75e-06	-3.308	0.001	-3.56e-05	-9.11e-06
Money Flow Index	4.299e-06	8.77e-06	0.490	0.624	-1.29e-05	2.15e-05
Percent Above Low	-4.475e-05	1.71e-05	-2.623	0.009	-7.82e-05	-1.13e-05
Percent Below High	1.295e-05	1.34e-05	0.965	0.335	-1.34e-05	3.93e-05
Price Oscillator	6.06e-06	9.48e-06	0.640	0.522	-1.25e-05	2.46e-05
Trendline	2.48e-05	1.44e-05	1.722	0.085	-3.42e-06	5.3e-05
AssetToEquityRatio	-2.548e-06	1.3e-06	-1.964	0.049	-5.09e-06	-5.59e-09
AssetTurnover	-0.0001	5.63e-05	-2.054	0.040	-0.000	-5.31e-06
CurrentRatio	3.392e-06	1.69e-06	2.007	0.045	7.96e-08	6.7e-06
DebtToAssetRatio	2.605e-06	1.04e-06	2.500	0.012	5.63e-07	4.65e-06
DebtToEquityRatio	-2.576e-08	1.21e-06	-0.021	0.983	-2.4e-06	2.35e-06
MertonsDD	-0.0010	0.000	-6.752			

```
0.000        -0.001    -0.001
WorkingCapitalToAssets                            3.97e-06   2.04e-06      1.943
0.052     -3.38e-08  7.97e-06
WorkingCapitalToSales                              -0.0002   6.58e-05     -2.654
0.008        -0.000 -4.56e-05
Dividend Growth                                 -9.485e-07   6.45e-07     -1.471
0.141     -2.21e-06  3.16e-07
EPS                                              5.254e-07      1e-06      0.525
0.599     -1.43e-06  2.48e-06
Net Debt                                         -1.53e-13   3.65e-14     -4.193
0.000     -2.25e-13 -8.15e-14
Sales                                           -1.061e-13   3.43e-14     -3.094
0.002     -1.73e-13 -3.89e-14
Total Assets                                    -7.923e-14   2.58e-14     -3.068
0.002      -1.3e-13 -2.86e-14
EPS Growth 3M                                   -6.126e-06   1.53e-06     -4.002
0.000     -9.13e-06 -3.13e-06
EPS Growth 12M                                   2.182e-06   1.53e-06      1.423
0.155     -8.24e-07  5.19e-06
Net Debt Growth 3M                              -1.748e-06   1.95e-06     -0.897
0.370     -5.57e-06  2.07e-06
Net Debt Growth 12M                              5.675e-06   1.98e-06      2.872
0.004       1.8e-06  9.55e-06
Sales Growth 3M                                   4.22e-06   2.06e-06      2.051
0.040      1.87e-07  8.25e-06
Sales Growth 12M                                 -6.66e-06    2.1e-06     -3.169
0.002     -1.08e-05 -2.54e-06
Total Assets Growth 3M                          -2.435e-07   2.31e-06     -0.105
0.916     -4.77e-06  4.28e-06
Total Assets Growth 12M                         -2.601e-06   2.46e-06     -1.059
0.290     -7.42e-06  2.21e-06
CFO To Assets                                    4.355e-05   2.81e-05      1.551
0.121     -1.15e-05  9.86e-05
Capex To Assets                                    -0.0001    6.1e-05     -2.246
0.025        -0.000 -1.74e-05
Capex To FCF                                      6.95e-05   3.42e-05      2.030
0.042       2.4e-06     0.000
Capex To Sales                                      0.0002   6.51e-05      3.016
0.003      6.87e-05     0.000
EBIT To Assets                                   1.444e-05   2.83e-05      0.511
0.610      -4.1e-05  6.99e-05
Retained Earnings To Assets                        -0.0004   6.01e-05     -6.676
0.000        -0.001    -0.000
Downside Risk                                    3.345e-05   1.73e-05      1.932
0.053     -4.83e-07  6.74e-05
Index Beta                                        -2.09e-06   3.55e-07     -5.886
0.000     -2.79e-06 -1.39e-06
```

```
Log Market Cap                                          0.0002   6.04e-05      3.147
0.002      7.17e-05     0.000
Volatility 3M                                       -8.754e-05   1.47e-05     -5.939
0.000        -0.000 -5.86e-05
stock_3D SYSTEMS CORP                                   0.1609      0.014     11.264
0.000         0.133     0.189
stock_3M COMPANY                                        0.1423      0.012     11.416
0.000         0.118     0.167
stock_ABBOTT LABORATORIES                               0.0903      0.010      9.116
0.000         0.071     0.110
stock_ABBVIE INC                                        0.1833      0.018     10.070
0.000         0.148     0.219
stock_ALLERGAN INC                                      0.1434      0.009     15.113
0.000         0.125     0.162
stock_ALLERGAN PLC                                      0.1683      0.013     12.648
0.000         0.142     0.194
stock_ALTABA INC                                        0.1825      0.015     12.388
0.000         0.154     0.211
stock_ALTRIA GROUP INC.                                 0.1533      0.013     12.015
0.000         0.128     0.178
stock_AMAZON.COM INC                                    0.1494      0.015     10.035
0.000         0.120     0.179
stock_AMERICAN AIRLINES GROUP INC                       0.1433      0.017      8.373
0.000         0.110     0.177
stock_AMERICAN EXPRESS COMPANY                          0.0785      0.008      9.844
0.000         0.063     0.094
stock_AMERICAN INTL GROUP INC                           0.1021      0.014      7.505
0.000         0.075     0.129
stock_AMGEN INC                                         0.0915      0.009     10.550
0.000         0.074     0.108
stock_ANADARKO PETROLEUM CORP                           0.0978      0.008     12.627
0.000         0.083     0.113
stock_APACHE CORP                                       0.0568      0.014      4.038
0.000         0.029     0.084
stock_APPLE INC                                         0.1309      0.012     10.689
0.000         0.107     0.155
stock_APPLIED MATERIALS INC                             0.1080      0.010     11.289
0.000         0.089     0.127
stock_ARCONIC INC                                       0.0422      0.007      5.984
0.000         0.028     0.056
stock_AT&T INC. COM                                     0.1122      0.014      8.068
0.000         0.085     0.139
stock_Alphabet Inc. Cl A                                0.2024      0.018     11.450
0.000         0.168     0.237
stock_BAKER HUGHES INC                                  0.0945      0.009     11.076
0.000         0.078     0.111
stock_BANK OF AMERICA CORP                              0.2669      0.052      5.090
```

```
0.000         0.164     0.370
stock_BERKSHIRE HATHAWAY INC CL-B               0.1630      0.018      8.968
0.000         0.127     0.199
stock_BIOGEN INC                                0.1688      0.012     14.185
0.000         0.145     0.192
stock_BOEING CO                                 0.0769      0.009      8.299
0.000         0.059     0.095
stock_BOOKING HOLDINGS INC                      0.1898      0.015     12.281
0.000         0.159     0.220
stock_BRISTOL MYERS SQUIBB COMPANY              0.1327      0.011     12.504
0.000         0.112     0.153
stock_BROADCOM CORP                             0.1655      0.014     11.708
0.000         0.138     0.193
stock_BROADCOM INC                              0.2090      0.018     11.611
0.000         0.174     0.244
stock_CATERPILLAR INC                           0.0647      0.009      7.093
0.000         0.047     0.083
stock_CELGENE CORP                              0.1326      0.010     12.974
0.000         0.113     0.153
stock_CHESAPEAKE ENERGY CORP                    0.0682      0.016      4.174
0.000         0.036     0.100
stock_CHEVRON CORPORATION                       0.1637      0.019      8.770
0.000         0.127     0.200
stock_CISCO SYSTEMS INC                         0.0975      0.009     10.689
0.000         0.080     0.115
stock_CITIGROUP                                 0.2358      0.045      5.236
0.000         0.148     0.324
stock_COCA-COLA CO                              0.1313      0.013     10.439
0.000         0.107     0.156
stock_COMCAST CORP                              0.0961      0.009     10.691
0.000         0.078     0.114
stock_CONOCOPHILLIPS                            0.1432      0.016      9.039
0.000         0.112     0.174
stock_COVIDIEN PLC                              0.2103      0.017     12.561
0.000         0.177     0.243
stock_CVS HEALTH CORP                           0.1147      0.012      9.823
0.000         0.092     0.138
stock_DEERE & CO                                0.0556      0.010      5.698
0.000         0.036     0.075
stock_DELTA AIR LINES INC                       0.1560      0.016      9.833
0.000         0.125     0.187
stock_DIRECTV                                   0.1262      0.015      8.223
0.000         0.096     0.156
stock_DOLLAR GENERAL CORP                       0.1543      0.016      9.600
0.000         0.123     0.186
stock_DOW CHEMICAL CO                           0.0810      0.009      8.981
0.000         0.063     0.099
```

stock_E.I. Du Pont De Nemours A	0.0722	0.009	7.789	0.000	0.054	0.090
stock_EBAY INC	0.1879	0.016	11.397	0.000	0.156	0.220
stock_EMC CORPORATION	0.1141	0.009	12.320	0.000	0.096	0.132
stock_EOG RESOURCES INC	0.1212	0.009	13.575	0.000	0.104	0.139
stock_EXPRESS SCRIPTS HOLDING CO	0.0745	0.010	7.775	0.000	0.056	0.093
stock_EXXON MOBIL CORPORATION	0.1865	0.021	8.679	0.000	0.144	0.229
stock_FACEBOOK INC	0.2171	0.019	11.586	0.000	0.180	0.254
stock_FEDEX CORPORATION	0.1002	0.010	10.231	0.000	0.081	0.119
stock_FIRST SOLAR INC	0.1560	0.017	9.046	0.000	0.122	0.190
stock_FORD MOTOR CO(NEW)	0.0733	0.011	6.384	0.000	0.051	0.096
stock_FREEPORT-MCMORAN INC	0.0974	0.013	7.766	0.000	0.073	0.122
stock_GENERAL ELECTRIC CO	0.1500	0.018	8.332	0.000	0.115	0.185
stock_GENERAL MOTORS CO	0.1448	0.018	8.032	0.000	0.109	0.180
stock_GILEAD SCIENCES INC	0.1445	0.011	12.934	0.000	0.123	0.166
stock_GOLDMAN SACHS GROUP INC	0.2410	0.025	9.822	0.000	0.193	0.289
stock_GOPRO INC	0.1946	0.018	10.636	0.000	0.159	0.230
stock_HALLIBURTON CO (HOLDING CO)	0.1050	0.010	10.582	0.000	0.086	0.124
stock_HOME DEPOT INC	0.1160	0.011	10.522	0.000	0.094	0.138
stock_HP INC	0.0879	0.010	8.554	0.000	0.068	0.108
stock_INTEL CORP	0.1170	0.011	10.511	0.000	0.095	0.139
stock_INTL BUSINESS MACHINES CORP	0.1135	0.012	9.176	0.000	0.089	0.138
stock_JOHNSON AND JOHNSON	0.1375	0.013	10.821	0.000	0.113	0.162
stock_JPMORGAN CHASE & CO COM STK	0.3443	0.064	5.416	0.000	0.220	0.469
stock_KEURIG GREEN MOUNTAIN INC	0.1655	0.013	12.506			

```
0.000         0.140     0.191
stock_KINDER MORGAN INC                         0.1372      0.017      7.888
0.000         0.103     0.171
stock_LAS VEGAS SANDS CORP                      0.1657      0.017      9.963
0.000         0.133     0.198
stock_LILLY ELI & CO                            0.1296      0.011     11.275
0.000         0.107     0.152
stock_LINKEDIN CORP                             0.1981      0.018     10.815
0.000         0.162     0.234
stock_LOWES COMPANIES INC                       0.1054      0.010     10.827
0.000         0.086     0.125
stock_LYONDELLBASELL INDUSTRIES NV              0.1509      0.017      8.959
0.000         0.118     0.184
stock_MARATHON PETROLEUM CORP                   0.1477      0.018      8.006
0.000         0.112     0.184
stock_MASTERCARD INCORPORATED                   0.2324      0.018     12.916
0.000         0.197     0.268
stock_MCDONALDS CORP                            0.1322      0.013     10.363
0.000         0.107     0.157
stock_MEDTRONIC PLC                             0.1496      0.011     13.103
0.000         0.127     0.172
stock_MERCK & CO INC                            0.1372      0.012     11.332
0.000         0.113     0.161
stock_METLIFE  INC                              0.1720      0.025      6.765
0.000         0.122     0.222
stock_MICHAEL KORS HOLDINGS LTD                 0.2136      0.019     11.178
0.000         0.176     0.251
stock_MICRON TECHNOLOGY INC                     0.1122      0.010     11.094
0.000         0.092     0.132
stock_MICROSOFT CORP                            0.1369      0.012     11.104
0.000         0.113     0.161
stock_MONDELEZ INTERNATIONAL INC                0.1580      0.015     10.549
0.000         0.129     0.187
stock_MONSANTO COMPANY                          0.1725      0.015     11.144
0.000         0.142     0.203
stock_MORGAN STANLEY                            0.2094      0.023      9.058
0.000         0.164     0.255
stock_MYLAN NV                                  0.1362      0.011     12.231
0.000         0.114     0.158
stock_NATIONAL OILWELL VARCO  INC.              0.1420      0.016      8.817
0.000         0.110     0.174
stock_NETFLIX INC                               0.2052      0.016     12.512
0.000         0.173     0.237
stock_NEWMONT MINING CORP (HOLDING COMPANY)     0.0949      0.012      7.982
0.000         0.072     0.118
stock_NEWS CP - CL A                            0.1394      0.013     11.131
0.000         0.115     0.164
```

stock_NIKE INC CL-B	0.1440	0.012	12.236	0.000	0.121	0.167
stock_OCCIDENTAL PETROLEUM CORP	0.1303	0.012	10.690	0.000	0.106	0.154
stock_ORACLE CORP	0.1384	0.012	11.935	0.000	0.116	0.161
stock_PANDORA MEDIA INC	0.2348	0.020	11.961	0.000	0.196	0.273
stock_PENNEY J.C. CO INC (HOLDING COMPANY)	0.0553	0.010	5.558	0.000	0.036	0.075
stock_PEPSICO INC	0.1325	0.013	9.962	0.000	0.106	0.159
stock_PFIZER INC	0.1554	0.013	11.701	0.000	0.129	0.181
stock_PHILIP MORRIS INTERNATIONAL INC	0.2017	0.019	10.405	0.000	0.164	0.240
stock_PIONEER NAT RES CO	0.1980	0.014	13.850	0.000	0.170	0.226
stock_PRECISION CASTPARTS CORP	0.1519	0.014	11.190	0.000	0.125	0.179
stock_PROCTER & GAMBLE CO	0.1412	0.014	10.286	0.000	0.114	0.168
stock_QUALCOMM INC	0.1585	0.013	12.011	0.000	0.133	0.184
stock_REGENERON PHARMACEUTICALS INC	0.1549	0.018	8.846	0.000	0.121	0.189
stock_SALESFORCE.COM INC	0.1797	0.016	10.945	0.000	0.148	0.212
stock_SALIX PHARMACEUTICALS LTD	1.482e-11	1.92e-11	0.771	0.440	-2.28e-11	5.25e-11
stock_SANDISK CORP	0.1842	0.014	13.280	0.000	0.157	0.211
stock_SCHLUMBERGER LTD.	0.1437	0.013	11.126	0.000	0.118	0.169
stock_SKYWORKS SOLUTIONS INC	0.1829	0.016	11.217	0.000	0.151	0.215
stock_SOLARCITY CORP	0.2218	0.019	11.593	0.000	0.184	0.259
stock_SOUTHWEST AIRLINES CO	0.1205	0.010	11.615	0.000	0.100	0.141
stock_STARBUCKS CORPORATION	0.1770	0.013	13.501	0.000	0.151	0.203
stock_SUNEDISON INC	0.1297	0.042	3.095	0.002	0.048	0.212
stock_TARGET CORPORATION	0.1226	0.014	8.556	0.000	0.094	0.151
stock_TESLA INC	0.2039	0.018	11.215			

```
0.000         0.168     0.240
stock_TEXAS INSTRUMENTS INC                      0.1730      0.014     12.080
0.000         0.145     0.201
stock_TIME WARNER CABLE INC                      0.1446      0.016      9.138
0.000         0.114     0.176
stock_TIME WARNER INC.                           0.0757      0.007     11.026
0.000         0.062     0.089
stock_TWITTER INC                                0.1978      0.019     10.476
0.000         0.161     0.235
stock_UNION PACIFIC CORPORATION                  0.1502      0.013     11.655
0.000         0.125     0.175
stock_UNITED CONTINENTAL HOLDINGS IN             0.1245      0.016      7.991
0.000         0.094     0.155
stock_UNITED PARCEL SERVICE INC.CL B             0.1248      0.015      8.288
0.000         0.095     0.154
stock_UNITED TECHNOLOGIES CORP                   0.1288      0.013      9.937
0.000         0.103     0.154
stock_UNITEDHEALTH GROUP INC                     0.1402      0.013     10.559
0.000         0.114     0.166
stock_VALERO ENERGY CORP (NEW)                   0.1296      0.013      9.686
0.000         0.103     0.156
stock_VERIZON COMMUNICATIONS                     0.1198      0.016      7.496
0.000         0.088     0.151
stock_VISA INC                                   0.2206      0.017     12.867
0.000         0.187     0.254
stock_WALGREENS BOOTS ALLIANCE INC               0.1369      0.013     10.559
0.000         0.111     0.162
stock_WALMART INC                                0.1522      0.021      7.225
0.000         0.111     0.194
stock_WALT DISNEY CO                             0.1309      0.010     13.023
0.000         0.111     0.151
stock_WELLS FARGO & CO(NEW)                      0.2969      0.043      6.946
0.000         0.213     0.381
stock_WILLIAMS COMPANIES                         0.1325      0.013     10.104
0.000         0.107     0.158
stock_WYNN RESORTS LTD                           0.1418      0.016      8.999
0.000         0.111     0.173
stock_YELP INC                                   0.1947      0.019     10.257
0.000         0.157     0.232
==============================================================================
Omnibus:                        0.654   Durbin-Watson:                   1.503
Prob(Omnibus):                  0.721   Jarque-Bera (JB):                0.669
Skew:                          -0.007   Prob(JB):                        0.716
Kurtosis:                       2.986   Cond. No.                     6.39e+16
==============================================================================

Warnings:
```

```
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The condition number is large, 6.39e+16. This might indicate that there are
strong multicollinearity or other numerical problems.
"""
```

[186]:
```
target = 'Returns20D'
model_data = pd.concat([y[[target]], X], axis=1).dropna()
model_data = model_data[model_data[target].between(model_data[target].quantile(.
 ↪025),
                                                    model_data[target].quantile(.
 ↪975))]

model = OLS(endog=model_data[target], exog=model_data.drop(target, axis=1))
trained_model = model.fit()
trained_model.summary()
```

[186]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results
==============================================================================
Dep. Variable:             Returns20D   R-squared:                       0.072
Model:                            OLS   Adj. R-squared:                  0.068
Method:                 Least Squares   F-statistic:                     19.10
Date:                Fri, 03 Aug 2018   Prob (F-statistic):               0.00
Time:                        21:42:21   Log-Likelihood:                 62705.
No. Observations:               42460   AIC:                        -1.251e+05
Df Residuals:                   42288   BIC:                        -1.236e+05
Df Model:                         171
Covariance Type:            nonrobust
================================================================================
===============================
                                                 coef    std err          t
P>|t|      [95.0% Conf. Int.]
--------------------------------------------------------------------------------
-------------------------------
DividendYield                               1.193e-05   2.23e-06      5.351
0.000       7.56e-06  1.63e-05
EBITDAYield                                   -0.0001   4.51e-05     -3.287
0.001         -0.000 -5.98e-05
EVToEBITDA                                     0.0003   4.07e-05      7.808
0.000          0.000     0.000
EVToFCF                                     -3.67e-06   4.99e-05     -0.074
0.941         -0.000  9.42e-05
PriceToBook                                  1.86e-05   4.73e-05      0.393
0.694      -7.41e-05     0.000
PriceToDilutedEarningsTTM                  -5.406e-05   2.12e-05     -2.549
```

				0.011	-9.56e-05	-1.25e-05
PriceToEarningsTTM	-8.22e-07	9.41e-07	-0.873	0.382	-2.67e-06	1.02e-06
PriceToFCF	2.678e-06	4.12e-05	0.065	0.948	-7.8e-05	8.33e-05
PriceToOperatingCashflow	-0.0001	2.91e-05	-4.551	0.000	-0.000	-7.54e-05
PriceToSalesTTM	-4.302e-05	2.5e-06	-17.222	0.000	-4.79e-05	-3.81e-05
Directional Movement Index	-3.389e-05	9.51e-06	-3.566	0.000	-5.25e-05	-1.53e-05
Money Flow Index	2.884e-05	1.23e-05	2.336	0.019	4.64e-06	5.3e-05
Percent Above Low	-7.04e-05	2.47e-05	-2.855	0.004	-0.000	-2.21e-05
Percent Below High	4.825e-05	1.89e-05	2.559	0.010	1.13e-05	8.52e-05
Price Oscillator	-5.428e-06	1.33e-05	-0.407	0.684	-3.15e-05	2.07e-05
Trendline	4.502e-05	2.04e-05	2.204	0.028	4.98e-06	8.51e-05
AssetToEquityRatio	-8.615e-06	1.86e-06	-4.637	0.000	-1.23e-05	-4.97e-06
AssetTurnover	-0.0002	8.11e-05	-2.720	0.007	-0.000	-6.16e-05
CurrentRatio	1.14e-05	2.4e-06	4.756	0.000	6.7e-06	1.61e-05
DebtToAssetRatio	2.131e-06	1.5e-06	1.421	0.155	-8.08e-07	5.07e-06
DebtToEquityRatio	4.261e-06	1.74e-06	2.445	0.014	8.45e-07	7.68e-06
MertonsDD	-0.0013	0.000	-6.145	0.000	-0.002	-0.001
WorkingCapitalToAssets	5.08e-06	2.89e-06	1.759	0.079	-5.8e-07	1.07e-05
WorkingCapitalToSales	-0.0004	9.31e-05	-4.593	0.000	-0.001	-0.000
Dividend Growth	-3.037e-06	9.15e-07	-3.319	0.001	-4.83e-06	-1.24e-06
EPS	2.228e-06	1.41e-06	1.583	0.113	-5.3e-07	4.99e-06
Net Debt	-2.368e-13	5.14e-14	-4.609	0.000	-3.37e-13	-1.36e-13
Sales	-2.182e-13	5.03e-14	-4.341	0.000	-3.17e-13	-1.2e-13
Total Assets	-2.513e-13	3.73e-14	-6.741	0.000	-3.24e-13	-1.78e-13

EPS Growth 3M	-1.786e-05	2.15e-06	-8.320	0.000	-2.21e-05	-1.37e-05
EPS Growth 12M	2.263e-06	2.15e-06	1.053	0.292	-1.95e-06	6.47e-06
Net Debt Growth 3M	-4.19e-06	2.73e-06	-1.533	0.125	-9.55e-06	1.17e-06
Net Debt Growth 12M	1.181e-06	2.76e-06	0.428	0.669	-4.23e-06	6.59e-06
Sales Growth 3M	-7.312e-07	2.88e-06	-0.254	0.800	-6.38e-06	4.92e-06
Sales Growth 12M	-1.036e-05	2.94e-06	-3.525	0.000	-1.61e-05	-4.6e-06
Total Assets Growth 3M	7.478e-06	3.24e-06	2.310	0.021	1.13e-06	1.38e-05
Total Assets Growth 12M	-3.848e-06	3.44e-06	-1.120	0.263	-1.06e-05	2.89e-06
CFO To Assets	9.296e-05	3.95e-05	2.352	0.019	1.55e-05	0.000
Capex To Assets	-0.0002	8.77e-05	-1.768	0.077	-0.000	1.68e-05
Capex To FCF	0.0002	4.86e-05	3.199	0.001	6.03e-05	0.000
Capex To Sales	0.0003	9.32e-05	2.992	0.003	9.62e-05	0.000
EBIT To Assets	4.836e-06	4e-05	0.121	0.904	-7.35e-05	8.32e-05
Retained Earnings To Assets	-0.0010	8.46e-05	-12.222	0.000	-0.001	-0.001
Downside Risk	-2.381e-05	2.45e-05	-0.972	0.331	-7.18e-05	2.42e-05
Index Beta	-4.429e-06	5.04e-07	-8.793	0.000	-5.42e-06	-3.44e-06
Log Market Cap	0.0001	8.62e-05	1.329	0.184	-5.44e-05	0.000
Volatility 3M	-0.0002	2.08e-05	-7.260	0.000	-0.000	-0.000
stock_3D SYSTEMS CORP	0.3173	0.020	15.578	0.000	0.277	0.357
stock_3M COMPANY	0.3182	0.018	17.973	0.000	0.284	0.353
stock_ABBOTT LABORATORIES	0.2168	0.014	14.970	0.000	0.188	0.245
stock_ABBVIE INC	0.3427	0.026	13.306	0.000	0.292	0.393
stock_ALLERGAN INC	0.3183	0.014	23.540	0.000	0.292	0.345
stock_ALLERGAN PLC	0.3267	0.019	17.361			

```
0.000         0.290     0.364
stock_ALTABA INC                                        0.3407      0.021     16.280
0.000         0.300     0.382
stock_ALTRIA GROUP INC.                                 0.3366      0.018     18.421
0.000         0.301     0.372
stock_AMAZON.COM INC                                    0.2840      0.021     13.457
0.000         0.243     0.325
stock_AMERICAN AIRLINES GROUP INC                       0.2416      0.024     10.047
0.000         0.194     0.289
stock_AMERICAN EXPRESS COMPANY                          0.1996      0.011     17.471
0.000         0.177     0.222
stock_AMERICAN INTL GROUP INC                           0.2697      0.020     13.737
0.000         0.231     0.308
stock_AMGEN INC                                         0.2179      0.012     17.559
0.000         0.194     0.242
stock_ANADARKO PETROLEUM CORP                           0.2158      0.011     19.604
0.000         0.194     0.237
stock_APACHE CORP                                       0.1494      0.056      2.651
0.008         0.039     0.260
stock_APPLE INC                                         0.3383      0.018     19.158
0.000         0.304     0.373
stock_APPLIED MATERIALS INC                             0.2390      0.014     17.579
0.000         0.212     0.266
stock_ARCONIC INC                                       0.1068      0.010     10.685
0.000         0.087     0.126
stock_AT&T INC. COM                                     0.2514      0.020     12.594
0.000         0.212     0.291
stock_Alphabet Inc. Cl A                                0.4051      0.025     16.157
0.000         0.356     0.454
stock_BAKER HUGHES INC                                  0.2139      0.012     17.586
0.000         0.190     0.238
stock_BANK OF AMERICA CORP                              0.7417      0.076      9.797
0.000         0.593     0.890
stock_BERKSHIRE HATHAWAY INC CL-B                       0.3567      0.026     13.681
0.000         0.306     0.408
stock_BIOGEN INC                                        0.3593      0.017     21.207
0.000         0.326     0.392
stock_BOEING CO                                         0.2107      0.013     15.879
0.000         0.185     0.237
stock_BOOKING HOLDINGS INC                              0.3602      0.022     16.449
0.000         0.317     0.403
stock_BRISTOL MYERS SQUIBB COMPANY                      0.3115      0.015     20.543
0.000         0.282     0.341
stock_BROADCOM CORP                                     0.2813      0.020     14.099
0.000         0.242     0.320
stock_BROADCOM INC                                      0.3808      0.026     14.895
0.000         0.331     0.431
```

stock_CATERPILLAR INC	0.1730	0.013	13.255	0.000	0.147	0.199
stock_CELGENE CORP	0.2960	0.015	20.285	0.000	0.267	0.325
stock_CHESAPEAKE ENERGY CORP	-4.999e-14	8.77e-14	-0.570	0.568	-2.22e-13	1.22e-13
stock_CHEVRON CORPORATION	0.3485	0.027	13.048	0.000	0.296	0.401
stock_CISCO SYSTEMS INC	0.2298	0.013	17.569	0.000	0.204	0.255
stock_CITIGROUP	0.6481	0.065	9.957	0.000	0.521	0.776
stock_COCA-COLA CO	0.2999	0.018	16.645	0.000	0.265	0.335
stock_COMCAST CORP	0.2309	0.013	17.938	0.000	0.206	0.256
stock_CONOCOPHILLIPS	0.2784	0.022	12.429	0.000	0.235	0.322
stock_COVIDIEN PLC	0.3792	0.024	15.807	0.000	0.332	0.426
stock_CVS HEALTH CORP	0.2568	0.017	15.384	0.000	0.224	0.289
stock_DEERE & CO	0.1513	0.014	10.763	0.000	0.124	0.179
stock_DELTA AIR LINES INC	0.2806	0.022	12.572	0.000	0.237	0.324
stock_DIRECTV	0.2139	0.022	9.864	0.000	0.171	0.256
stock_DOLLAR GENERAL CORP	0.2719	0.023	11.971	0.000	0.227	0.316
stock_DOW CHEMICAL CO	0.1912	0.013	14.832	0.000	0.166	0.216
stock_E.I. Du Pont De Nemours A	0.1633	0.013	12.300	0.000	0.137	0.189
stock_EBAY INC	0.3558	0.023	15.256	0.000	0.310	0.402
stock_EMC CORPORATION	0.2526	0.013	19.131	0.000	0.227	0.278
stock_EOG RESOURCES INC	0.2644	0.013	20.854	0.000	0.240	0.289
stock_EXPRESS SCRIPTS HOLDING CO	0.1640	0.014	11.874	0.000	0.137	0.191
stock_EXXON MOBIL CORPORATION	0.4155	0.031	13.352	0.000	0.355	0.477
stock_FACEBOOK INC	0.3934	0.026	14.853	0.000	0.341	0.445
stock_FEDEX CORPORATION	0.2296	0.014	16.546			

```
0.000         0.202     0.257
stock_FIRST SOLAR INC                             0.3130      0.025     12.617
0.000         0.264     0.362
stock_FORD MOTOR CO(NEW)                          0.1766      0.017     10.680
0.000         0.144     0.209
stock_FREEPORT-MCMORAN INC                        0.1663      0.018      9.357
0.000         0.131     0.201
stock_GENERAL ELECTRIC CO                         0.3810      0.026     14.621
0.000         0.330     0.432
stock_GENERAL MOTORS CO                           0.2661      0.026     10.406
0.000         0.216     0.316
stock_GILEAD SCIENCES INC                         0.3193      0.016     20.030
0.000         0.288     0.351
stock_GOLDMAN SACHS GROUP INC                     0.5289      0.035     14.945
0.000         0.460     0.598
stock_GOPRO INC                                   0.3186      0.026     12.297
0.000         0.268     0.369
stock_HALLIBURTON CO (HOLDING CO)                 0.2384      0.014     16.933
0.000         0.211     0.266
stock_HOME DEPOT INC                              0.2761      0.016     17.535
0.000         0.245     0.307
stock_HP INC                                      0.2021      0.015     13.749
0.000         0.173     0.231
stock_INTEL CORP                                  0.2633      0.016     16.526
0.000         0.232     0.294
stock_INTL BUSINESS MACHINES CORP                 0.2830      0.018     15.965
0.000         0.248     0.318
stock_JOHNSON AND JOHNSON                         0.3200      0.018     17.592
0.000         0.284     0.356
stock_JPMORGAN CHASE & CO COM STK                 0.8913      0.092      9.698
0.000         0.711     1.071
stock_KEURIG GREEN MOUNTAIN INC                   0.3387      0.019     18.109
0.000         0.302     0.375
stock_KINDER MORGAN INC                           0.2413      0.025      9.811
0.000         0.193     0.289
stock_LAS VEGAS SANDS CORP                        0.2950      0.024     12.543
0.000         0.249     0.341
stock_LILLY ELI & CO                              0.2792      0.016     16.965
0.000         0.247     0.311
stock_LINKEDIN CORP                               0.3443      0.026     13.316
0.000         0.294     0.395
stock_LOWES COMPANIES INC                         0.2297      0.014     16.545
0.000         0.202     0.257
stock_LYONDELLBASELL INDUSTRIES NV                0.2773      0.024     11.680
0.000         0.231     0.324
stock_MARATHON PETROLEUM CORP                     0.2467      0.026      9.411
0.000         0.195     0.298
```

stock_MASTERCARD INCORPORATED	0.4555	0.025	17.920	0.000	0.406	0.505
stock_MCDONALDS CORP	0.2920	0.018	16.033	0.000	0.256	0.328
stock_MEDTRONIC PLC	0.3192	0.016	19.660	0.000	0.287	0.351
stock_MERCK & CO INC	0.3003	0.017	17.338	0.000	0.266	0.334
stock_METLIFE INC	0.3781	0.037	10.338	0.000	0.306	0.450
stock_MICHAEL KORS HOLDINGS LTD	0.3756	0.027	13.904	0.000	0.323	0.429
stock_MICRON TECHNOLOGY INC	0.2171	0.014	15.211	0.000	0.189	0.245
stock_MICROSOFT CORP	0.3047	0.018	17.242	0.000	0.270	0.339
stock_MONDELEZ INTERNATIONAL INC	0.2891	0.021	13.662	0.000	0.248	0.331
stock_MONSANTO COMPANY	0.3312	0.022	15.138	0.000	0.288	0.374
stock_MORGAN STANLEY	0.4563	0.033	13.722	0.000	0.391	0.521
stock_MYLAN NV	0.2558	0.016	16.113	0.000	0.225	0.287
stock_NATIONAL OILWELL VARCO INC.	0.2658	0.023	11.681	0.000	0.221	0.310
stock_NETFLIX INC	0.3875	0.023	16.682	0.000	0.342	0.433
stock_NEWMONT MINING CORP (HOLDING COMPANY)	0.1446	0.017	8.514	0.000	0.111	0.178
stock_NEWS CP - CL A	0.2669	0.018	15.067	0.000	0.232	0.302
stock_NIKE INC CL-B	0.3016	0.017	18.078	0.000	0.269	0.334
stock_OCCIDENTAL PETROLEUM CORP	0.2756	0.017	15.892	0.000	0.242	0.310
stock_ORACLE CORP	0.2984	0.017	18.058	0.000	0.266	0.331
stock_PANDORA MEDIA INC	0.3925	0.028	14.067	0.000	0.338	0.447
stock_PENNEY J.C. CO INC (HOLDING COMPANY)	0.0737	0.014	5.167	0.000	0.046	0.102
stock_PEPSICO INC	0.2931	0.019	15.449	0.000	0.256	0.330
stock_PFIZER INC	0.3336	0.019	17.563	0.000	0.296	0.371
stock_PHILIP MORRIS INTERNATIONAL INC	0.3844	0.028	13.959			

```
0.000         0.330     0.438
stock_PIONEER NAT RES CO                          0.3579      0.020     17.747
0.000         0.318     0.397
stock_PRECISION CASTPARTS CORP                    0.3008      0.020     14.774
0.000         0.261     0.341
stock_PROCTER & GAMBLE CO                         0.3094      0.020     15.745
0.000         0.271     0.348
stock_QUALCOMM INC                                0.3232      0.019     17.225
0.000         0.286     0.360
stock_REGENERON PHARMACEUTICALS INC               0.3153      0.043      7.267
0.000         0.230     0.400
stock_SALESFORCE.COM INC                          0.3156      0.023     13.571
0.000         0.270     0.361
stock_SALIX PHARMACEUTICALS LTD               -5.165e-15   7.41e-15     -0.697
0.486     -1.97e-14  9.37e-15
stock_SANDISK CORP                                0.3350      0.020     17.064
0.000         0.296     0.373
stock_SCHLUMBERGER LTD.                           0.3011      0.018     16.396
0.000         0.265     0.337
stock_SKYWORKS SOLUTIONS INC                      0.3422      0.023     14.843
0.000         0.297     0.387
stock_SOLARCITY CORP                              0.3803      0.027     14.070
0.000         0.327     0.433
stock_SOUTHWEST AIRLINES CO                       0.2513      0.015     16.796
0.000         0.222     0.281
stock_STARBUCKS CORPORATION                       0.3558      0.019     19.139
0.000         0.319     0.392
stock_SUNEDISON INC                            1.713e-16   2.85e-16      0.601
0.548     -3.87e-16   7.3e-16
stock_TARGET CORPORATION                          0.2298      0.020     11.314
0.000         0.190     0.270
stock_TESLA INC                                   0.3540      0.026     13.789
0.000         0.304     0.404
stock_TEXAS INSTRUMENTS INC                       0.3573      0.021     17.423
0.000         0.317     0.397
stock_TIME WARNER CABLE INC                       0.2637      0.022     11.821
0.000         0.220     0.307
stock_TIME WARNER INC.                            0.1773      0.010     18.052
0.000         0.158     0.197
stock_TWITTER INC                                 0.3333      0.027     12.463
0.000         0.281     0.386
stock_UNION PACIFIC CORPORATION                   0.3164      0.018     17.283
0.000         0.281     0.352
stock_UNITED CONTINENTAL HOLDINGS IN              0.1975      0.022      8.977
0.000         0.154     0.241
stock_UNITED PARCEL SERVICE INC.CL B              0.2391      0.021     11.199
0.000         0.197     0.281
```

```
stock_UNITED TECHNOLOGIES CORP                    0.2750      0.018     14.928
0.000          0.239     0.311
stock_UNITEDHEALTH GROUP INC                      0.2970      0.019     15.679
0.000          0.260     0.334
stock_VALERO ENERGY CORP (NEW)                    0.2539      0.019     13.356
0.000          0.217     0.291
stock_VERIZON COMMUNICATIONS                      0.2472      0.023     10.825
0.000          0.202     0.292
stock_VISA INC                                    0.4192      0.024     17.309
0.000          0.372     0.467
stock_WALGREENS BOOTS ALLIANCE INC                0.2793      0.018     15.194
0.000          0.243     0.315
stock_WALMART INC                                 0.3251      0.031     10.594
0.000          0.265     0.385
stock_WALT DISNEY CO                              0.3131      0.014     21.827
0.000          0.285     0.341
stock_WELLS FARGO & CO(NEW)                       0.7175      0.062     11.586
0.000          0.596     0.839
stock_WILLIAMS COMPANIES                          0.2522      0.019     13.501
0.000          0.216     0.289
stock_WYNN RESORTS LTD                            0.2461      0.022     11.047
0.000          0.202     0.290
stock_YELP INC                                    0.3195      0.027     11.882
0.000          0.267     0.372
==============================================================================
Omnibus:                       26.157   Durbin-Watson:                   1.605
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               26.187
Skew:                           0.059   Prob(JB):                     2.06e-06
Kurtosis:                       2.970   Cond. No.                     1.95e+19
==============================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
[2] The smallest eigenvalue is 9.91e-12. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.
"""
```

sklearn

[142]:
```python
def time_series_split(d, nfolds=5, min_train=21):
    """Generate train/test dates for nfolds
    with at least min_train train obs
    """
    train_dates = d[:min_train].tolist()
    n = int(len(dates)/(nfolds + 1)) + 1
    test_folds = [d[i:i + n] for i in range(min_train, len(d), n)]
```

```
    for test_dates in test_folds:
        if len(train_dates) > min_train:
            yield train_dates, test_dates
        train_dates.extend(test_dates)
```

[264]:
```
target = 'Returns10D'
outliers = .01
model_data = pd.concat([y[[target]], X], axis=1).dropna().reset_index('asset',␣
↪drop=True)
model_data = model_data[model_data[target].between(*model_data[target].
↪quantile([outliers, 1-outliers]).values)]

model_data[target] = np.log1p(model_data[target])
features = model_data.drop(target, axis=1).columns
dates = model_data.index.unique()

print(model_data.info())
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 45114 entries, 2014-01-02 to 2015-12-16
Columns: 183 entries, Returns10D to stock_YELP INC
dtypes: float64(183)
memory usage: 63.3 MB
None
```

[265]:
```
model_data[target].describe()
```

[265]:
```
count    45114.000000
mean         0.001159
std          0.045740
min         -0.157448
25%         -0.025013
50%          0.002817
75%          0.028880
max          0.146139
Name: Returns10D, dtype: float64
```

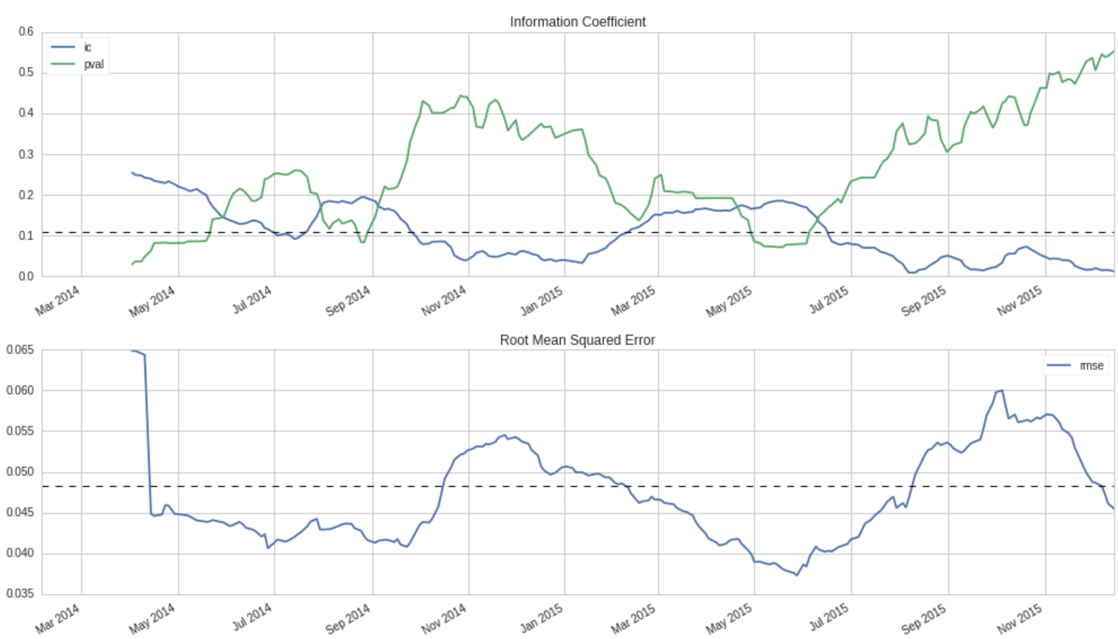
[266]:
```
idx = pd.IndexSlice
```

[267]:
```
nfolds = 250
lr = LinearRegression()

test_results, result_idx, preds = [], [], pd.DataFrame()
for train_dates, test_dates in time_series_split(dates, nfolds=nfolds):

    X_train = model_data.loc[idx[train_dates], features]
    y_train = model_data.loc[idx[train_dates], target]
```

```
    lr.fit(X=X_train, y=y_train)

    X_test = model_data.loc[idx[test_dates], features]
    y_test = model_data.loc[idx[test_dates], target]
    y_pred = lr.predict(X_test)

    rmse = np.sqrt(mean_squared_error(y_pred=y_pred, y_true=y_test))
    ic, pval = spearmanr(y_pred, y_test)

    test_results.append([rmse, ic, pval])
    preds = preds.append(y_test.to_frame('actuals').assign(predicted=y_pred))
    result_idx.append(train_dates[-1])
```

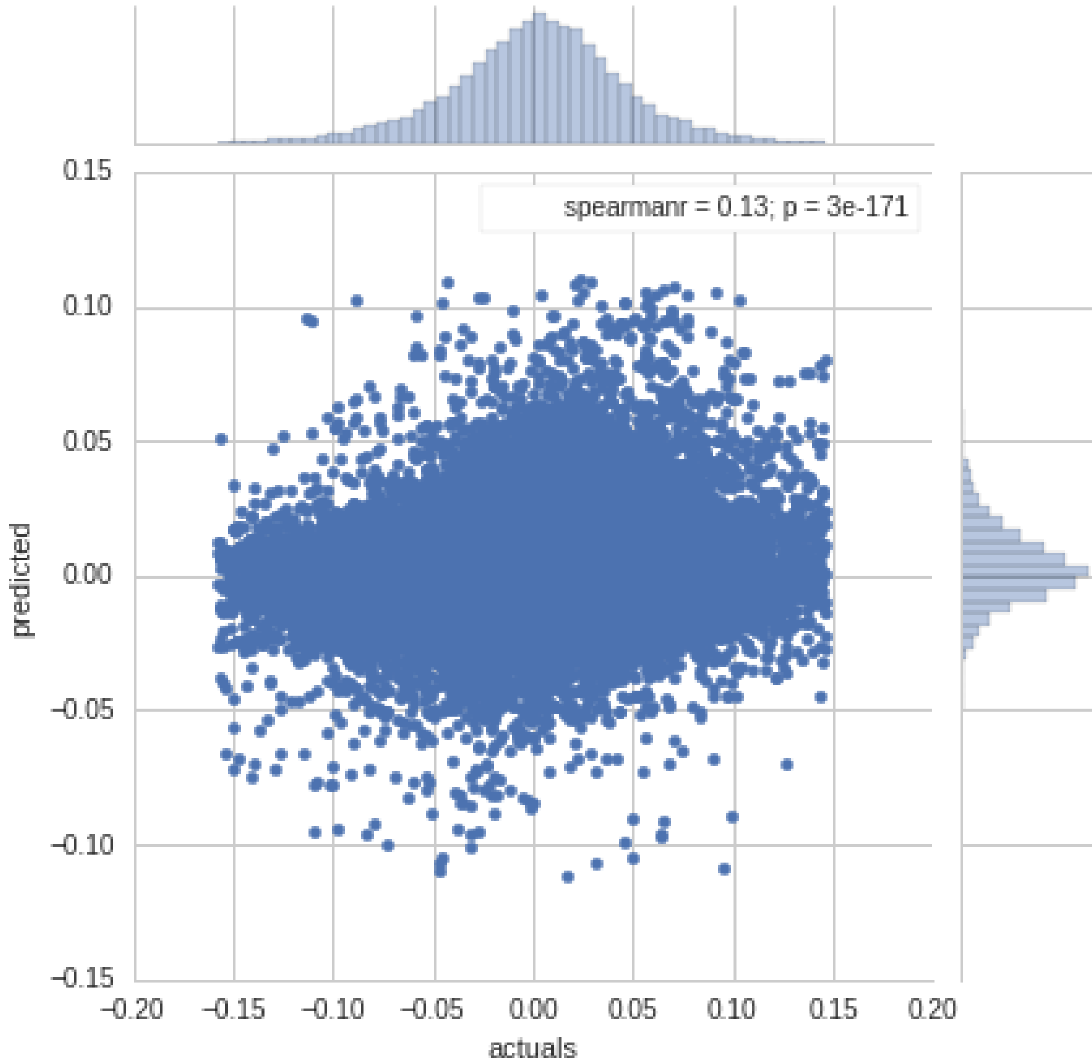
[268]:
```
test_result = pd.DataFrame(test_results, columns=['rmse', 'ic', 'pval'],␣
 ↪index=result_idx)
```

[274]:
```
fig, axes = plt.subplots(nrows=2)
rolling_result = test_result.rolling(21).mean()
rolling_result[['ic', 'pval']].plot(ax=axes[0], title='Information Coefficient')
axes[0].axhline(test_result.ic.mean(), lw=1, ls='--', color='k')
rolling_result[['rmse']].plot(ax=axes[1], title='Root Mean Squared Error')
axes[1].axhline(test_result.rmse.mean(), lw=1, ls='--', color='k')
plt.tight_layout();
```



[273]:
```
preds_cleaned = preds[(preds.predicted.between(*preds.predicted.quantile([.001,␣
 ↪.999]).values))]
```

```
sns.jointplot(x='actuals', y='predicted', data=preds_cleaned,␣
↪stat_func=spearmanr);
```



1.1.12 Ridge Regression: Regularization

[228]:
```
nfolds = 250
alphas = np.logspace(-10, 10, 21)
scaler = StandardScaler()

result = pd.DataFrame()
for alpha in alphas:
    test_results = []
    lr_ridge = Ridge(alpha=alpha)
```

```python
    for train_dates, test_dates in time_series_split(dates, nfolds=nfolds):

        X_train = model_data.loc[idx[train_dates], features]
        y_train = model_data.loc[idx[train_dates], target]
        lr_ridge.fit(X=scaler.fit_transform(X_train), y=y_train)

        X_test = model_data.loc[idx[test_dates], features]
        y_test = model_data.loc[idx[test_dates], target]
        y_pred = lr_ridge.predict(scaler.transform(X_test))

        rmse = np.sqrt(mean_squared_error(y_pred=y_pred, y_true=y_test))
        ic, pval = spearmanr(y_pred, y_test)

        test_results.append([train_dates[-1], rmse, ic, pval, alpha])
    result = result.append(pd.DataFrame(test_results, columns=['date', 'rmse',␣
↪'ic', 'pval', 'alpha']))
```

[218]:

```python
result.describe()
```

[218]:

	rmse	ic	pval	alpha
count	2596.000000	2596.000000	2.596000e+03	2596.000000
mean	0.041313	0.103199	2.613618e-01	10101.010101
std	0.010541	0.135611	3.065827e-01	28575.475238
min	0.026114	-0.336232	2.597238e-14	0.000010
25%	0.035069	0.006434	7.973453e-03	0.001000
50%	0.038960	0.104842	1.109634e-01	1.000000
75%	0.044604	0.195338	4.629843e-01	1000.000000
max	0.186661	0.539700	9.990920e-01	100000.000000

[232]:

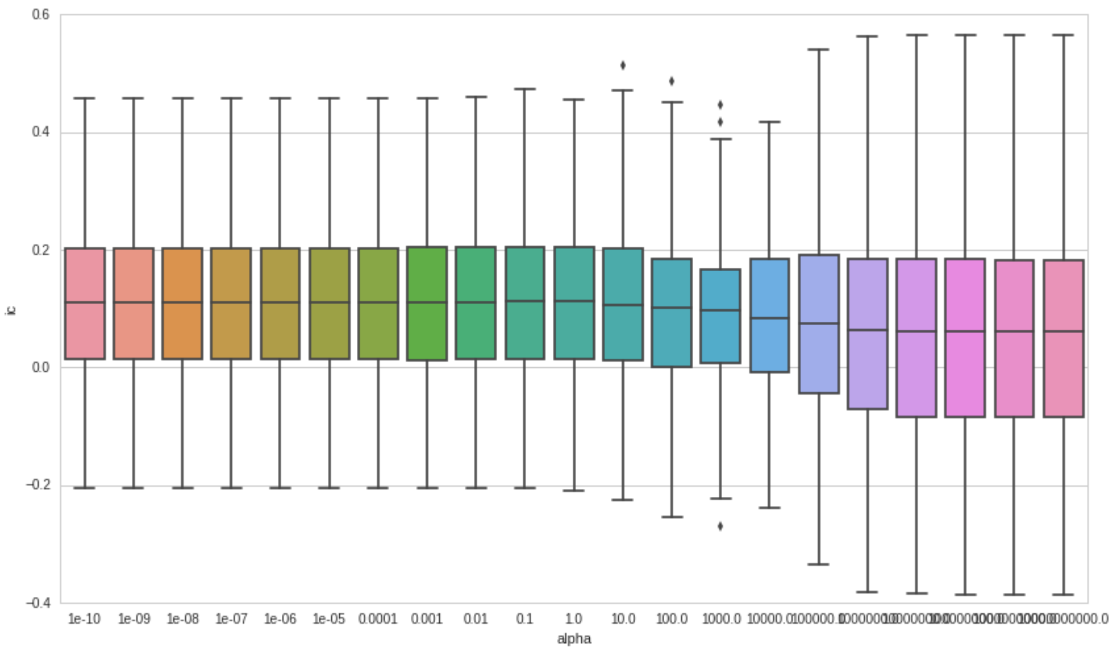
```python
result.groupby('alpha').mean()
```

[232]:

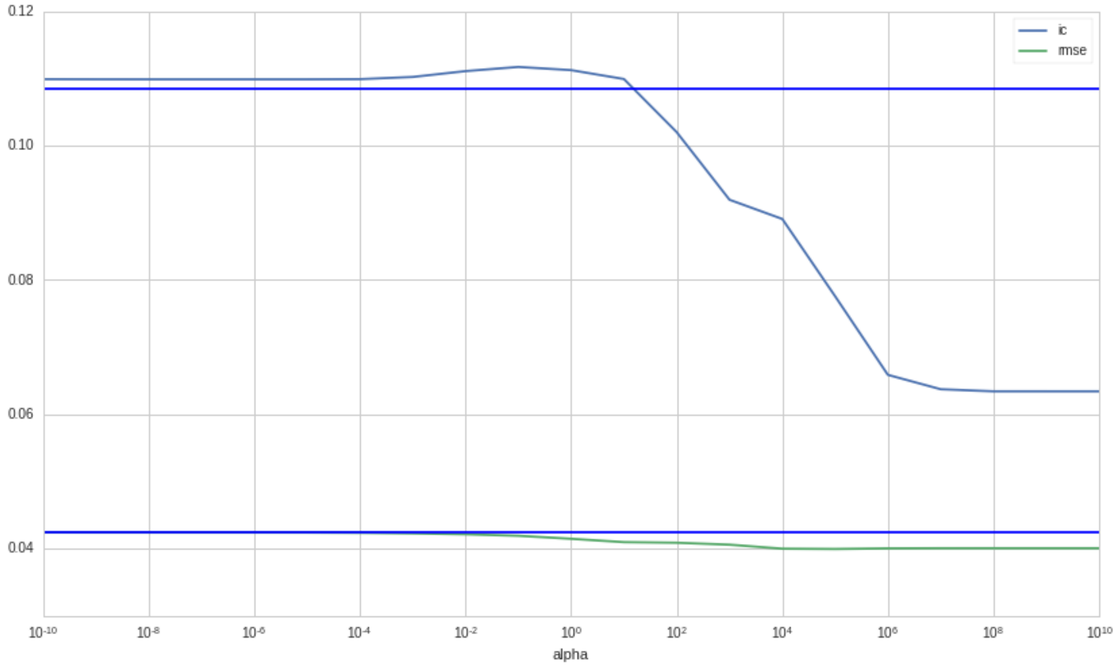
alpha	rmse	ic	pval
1.000000e-10	0.042368	0.109963	0.260145
1.000000e-09	0.042360	0.109947	0.260122
1.000000e-08	0.042359	0.109942	0.260093
1.000000e-07	0.042359	0.109942	0.260093
1.000000e-06	0.042358	0.109942	0.260093
1.000000e-05	0.042352	0.109942	0.260122
1.000000e-04	0.042315	0.109966	0.260172
1.000000e-03	0.042227	0.110292	0.260159
1.000000e-02	0.042099	0.111161	0.259692
1.000000e-01	0.041870	0.111786	0.259461
1.000000e+00	0.041424	0.111308	0.257907
1.000000e+01	0.040923	0.109983	0.262471
1.000000e+02	0.040834	0.102059	0.262682
1.000000e+03	0.040544	0.091980	0.283376

```
1.000000e+04  0.039948  0.089116  0.283867
1.000000e+05  0.039902  0.077597  0.225071
1.000000e+06  0.039993  0.065869  0.220311
1.000000e+07  0.040015  0.063724  0.218205
1.000000e+08  0.040018  0.063412  0.217982
1.000000e+09  0.040018  0.063412  0.217846
1.000000e+10  0.040018  0.063411  0.217820
```

[230]:
```python
sns.boxplot(y='ic', x='alpha', data=result);
```



[250]:
```python
ax = result.groupby('alpha')['ic', 'rmse'].mean().plot(logx=True)
ax.axhline(test_result.ic.mean())
ax.axhline(test_result.rmse.mean());
```




```
[ ]: nfolds = 250
     alphas = np.logspace(-5, 5, 11)
     scaler = StandardScaler()

     result2 = pd.DataFrame()
     for alpha in alphas:
         test_results = []
         print(alpha)
         lr_lasso = Lasso(alpha=alpha)
         for i, (train_dates, test_dates) in enumerate(time_series_split(dates,␣
      ↪nfolds=nfolds)):
             if i % 50 == 0:
                 print('\t{}'.format(i))

             X_train = model_data.loc[idx[train_dates], features]
             y_train = model_data.loc[idx[train_dates], target]
             lr_lasso.fit(X=scaler.fit_transform(X_train), y=y_train)

             X_test = model_data.loc[idx[test_dates], features]
             y_test = model_data.loc[idx[test_dates], target]
             y_pred = lr_lasso.predict(scaler.transform(X_test))

     #         mse = mean_squared_error(y_pred=y_pred, y_true=y_test)
             rmse = np.sqrt(np.sum((y_test-y_pred)**2))
             ic, pval = spearmanr(y_pred, y_test)
```

```
        test_results.append([train_dates[-1], rmse, ic, pval, alpha])
    result2 = result2.append(pd.DataFrame(test_results, columns=['date',␣
 ↪'rmse', 'ic', 'pval', 'alpha']))
```

[224]:
```
result2.groupby('alpha').mean()
```

[224]:

alpha	rmse	ic	pval
0.00001	0.543842	0.110453	0.246888
0.00010	0.534970	0.102119	0.267977
0.00100	0.529708	0.056725	0.283635
0.01000	0.530549	NaN	NaN
0.10000	0.530549	NaN	NaN
1.00000	0.530549	NaN	NaN
10.00000	0.530549	NaN	NaN
100.00000	0.530549	NaN	NaN
1000.00000	0.530549	NaN	NaN
10000.00000	0.530549	NaN	NaN
100000.00000	0.530549	NaN	NaN

1.1.13 Logistic Regression: Classification

[275]:
```
target = 'Returns10D'
label = (y[target] > 0).astype(int).to_frame(target)
model_data = pd.concat([label, X], axis=1).dropna().reset_index('asset',␣
 ↪drop=True)

features = model_data.drop(target, axis=1).columns
dates = model_data.index.unique()

print(model_data.info())
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 47377 entries, 2014-01-02 to 2015-12-31
Columns: 183 entries, Returns10D to stock_YELP INC
dtypes: float64(182), int64(1)
memory usage: 66.5 MB
None
```

[285]:
```
nfolds = 250
Cs = np.logspace(-5, 5, 11)
scaler = StandardScaler()

# logistic_result = pd.DataFrame(columns=['date', 'rmse', 'ic', 'pval', 'C'])
logistic_preds = pd.DataFrame(columns=['actuals', 'predicted', 'C'])
for C in Cs:
```

```
    result = []
    print(C)
    log_reg = LogisticRegression(C=C)
    for i, (train_dates, test_dates) in enumerate(time_series_split(dates,␣
↪nfolds=nfolds)):

        X_train = model_data.loc[idx[train_dates], features]
        y_train = model_data.loc[idx[train_dates], target]
        log_reg.fit(X=scaler.fit_transform(X_train), y=y_train)

        X_test = model_data.loc[idx[test_dates], features]
        y_test = model_data.loc[idx[test_dates], target]
        y_pred = log_reg.predict_proba(scaler.transform(X_test))[:, 1]

#         rmse = np.sqrt(mean_squared_error(y_pred=y_pred, y_true=y_test))
#         ic, pval = spearmanr(y_pred, y_test)
        logistic_preds = (logistic_preds
                          .append(y_test
                                  .to_frame('actuals')
                                  .assign(predicted=y_pred, C=C)))

#         result.append([train_dates[-1], rmse, ic, pval, alpha])
#     logistic_result = logistic_result.append(pd.DataFrame(result))
```

```
1e-05
0.0001
0.001
0.01
0.1
1.0
10.0
100.0
1000.0
10000.0
100000.0
```

[286]:
```
logistic_preds.info()
```

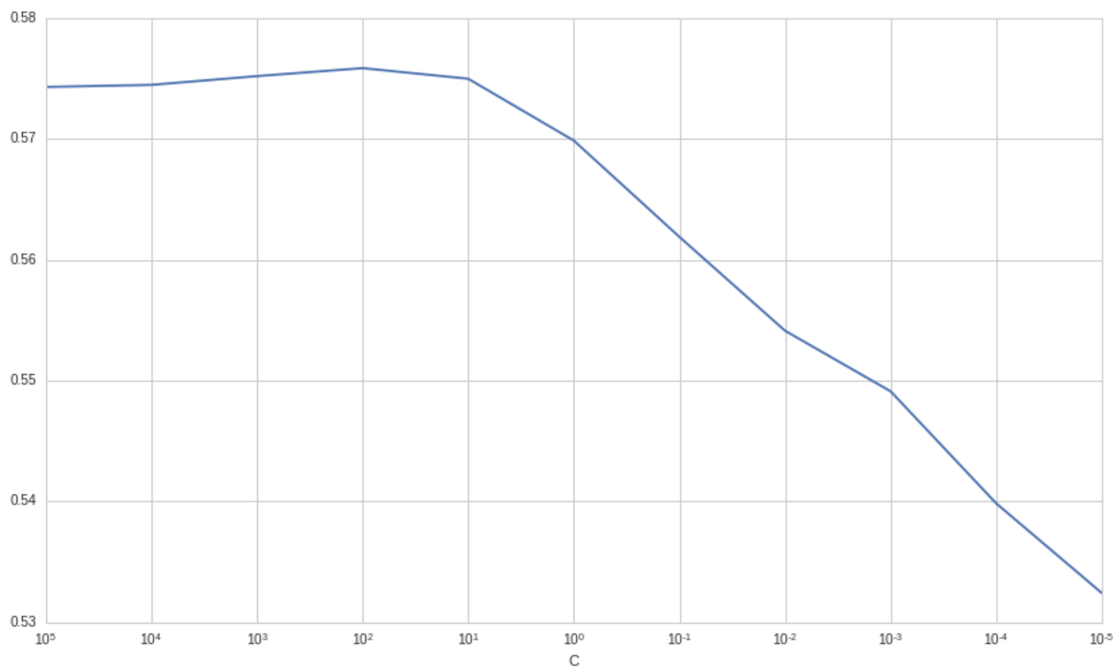
```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 497002 entries, 2014-02-06 to 2015-12-31
Data columns (total 3 columns):
C            497002 non-null float64
actuals      497002 non-null float64
predicted    497002 non-null float64
dtypes: float64(3)
memory usage: 15.2 MB
```

[287]:
```
from sklearn.metrics import roc_auc_score
```

[292]:
```
auc = logistic_preds.groupby('C').apply(lambda x: roc_auc_score(y_true=x.
 ↪actuals.astype(int),
                                                          y_score=x.predicted))
auc
```

[292]:
```
C
0.00001         0.532385
0.00010         0.539814
0.00100         0.549100
0.01000         0.554121
0.10000         0.561894
1.00000         0.569875
10.00000        0.574998
100.00000       0.575875
1000.00000      0.575214
10000.00000     0.574488
100000.00000    0.574317
dtype: float64
```

[296]:
```
auc.sort_index(ascending=False).plot(logx=True);
```



[ ]:
```
logistic_preds.info()
```

1.1.14 Ordinal Logit

[ ]:
```python
target = 'Returns10D'
label = (y[target] > 0).astype(int).to_frame(target)
model_data = pd.concat([label, X], axis=1).dropna().reset_index('asset',␣
 ↪drop=True)

features = model_data.drop(target, axis=1).columns
dates = model_data.index.unique()

print(model_data.info())
```

[ ]:
```python

```

[ ]:
```python

```

1.2 TA-Lib

[ ]:
```python
class Technical:
    @staticmethod
    def make_bbands(timeperiod=5, nbdevup=2, nbdevdn=2, matype=0):
        class BBANDS(CustomFactor):
            """Lower, middle, and upper Bollinger Bands"""

            inputs = [USEquityPricing.close]
            outputs = ['upper', 'middle', 'lower']
            window_length = timeperiod

            def compute(self, today, assets, out, close_prices):
                bb = []
                for close in close_prices.T:
                    u, m, l = talib.BBANDS(close, timeperiod=timeperiod,
                                  nbdevup=nbdevup, nbdevdn=nbdevdn,
                                  matype=matype)
                    bb.append((u[-1], m[-1], l[-1]))
                out.upper[:], out.middle[:], out.lower[:] = list(zip(*bb))
        return BBANDS

    @staticmethod
    def make_ema(timeperiod=30):
        class EMA(CustomFactor):
            """Double Exponential Moving Average"""
            inputs = [USEquityPricing.close]
            window_length = timeperiod

            def compute(self, today, assets, out, close_prices):
```

```
            out[:] = [talib.EMA(p, timeperiod=timeperiod)[-1] for p in␣
↪close_prices.T]
        return EMA

    @staticmethod
    def make_dx(timeperiod=14):
        class DX(CustomFactor):
            """Directional Movement Index"""
            inputs = [USEquityPricing.high,
                      USEquityPricing.low,
                      USEquityPricing.close]
            window_length = timeperiod + 1

            def compute(self, today, assets, out, high, low, close):
                out[:] = [talib.DX(high[:, i],
                                   low[:, i],
                                   close[:, i],
                                   timeperiod=timeperiod)[-1]
                          for i in range(len(assets))]
        return DX


    @staticmethod
    def make_mfi(timeperiod=14):
        class MFI(CustomFactor):
            """Money Flow Index"""
            inputs = [USEquityPricing.high,
                      USEquityPricing.low,
                      USEquityPricing.close,
                      USEquityPricing.volume]
            window_length = timeperiod + 1

            def compute(self, today, assets, out, high, low, close, vol):
                out[:] = [talib.MFI(high[:, i],
                                    low[:, i],
                                    close[:, i],
                                    vol[:, i],
                                    timeperiod=timeperiod)[-1]
                          for i in range(len(assets))]
        return MFI
```

[1]:
```
def test_pipeline():
    stocks = StaticAssets(symbols(['MSFT', 'AAPL']))
#     DX = Technical.make_dx()
    MFI = Technical.make_mfi()

    ewma = EWMA(inputs=[USEquityPricing.high],
```

```
                        window_length=30,
                        decay_rate=.2,
                        mask=stocks)
    bb = BollingerBands(window_length=30, k=2, mask=stocks)
    return Pipeline({'adx': Technical.make_dx()(mask=stocks),
                     'mfi': MFI(mask=stocks),
                     'ewma': ewma,
                     'lower': bb.lower,
                     'mid': bb.middle,
                     'up': bb.upper},
                    screen=stocks)
```

[ ]:
```
start_timer = time()
result = run_pipeline(test_pipeline(),
                      start_date='2018-05-01',
                      end_date='2018-07-31')
print('Pipeline run time {:.2f} secs'.format(time() - start_timer))
result.tail(10)
```

[31]:
```
def momentum_pipeline_alt():
    ewma = EWMA(inputs=[USEquityPricing.high],
                        window_length=30,
                        decay_rate=.2,
                        mask=UNIVERSE)
    bb = BollingerBands(window_length=30, k=2, mask=UNIVERSE)

    STOCH = MomentumFactors.make_stochastic_oscillator()
    spo = STOCH(mask=UNIVERSE)

    columns = {'ewma': ewma,
               'so_slowk': spo.slowk,
               'so_slowd': spo.slowd,
               'bb_lower': bb.lower,
               'bb_mid': bb.middle,
               'bb_up': bb.upper}
    columns.update({k: v(mask=UNIVERSE) for k, v in MOMENTUM_FACTORS.items()})

    return Pipeline(columns,
                    screen=UNIVERSE)
```

[ ]:
```

```