03_101_formulaic_alphas

September 29, 2021

1 101 Formulaic Alphas

Based on 101 Formulaic Alphas, Zura Kakushadze, arxiv, 2015

1.1 Imports & Settings

[4]:
```
import warnings
warnings.filterwarnings('ignore')
```

[5]:
```
%matplotlib inline

import numpy as np
import pandas as pd
from sklearn.feature_selection import mutual_info_regression
from scipy.stats import spearmanr
import matplotlib.pyplot as plt
import seaborn as sns
from talib import WMA
```

[6]:
```
idx= pd.IndexSlice
sns.set_style('whitegrid')
```

> "An alpha is a combination of mathematical expressions, computer source code, and configuration parameters that can be used, in combination with historical data, to make predictions about future movements of various financial instruments"

Finding Alphas: A Quantitative Approach to Building Trading Strategies, Igor Tulchinsky, 2019

1.2 Functions

The expressions below that define the 101 formulaic alphas contain functions for both time-series and cross-sectional computations.

1.2.1 Cross-section

Function	Definition
rank(x)	Cross-sectional rank
scale(x, a)	Rescaled x such that sum(abs(x)) = a (the default is a = 1)

Function	Definition
indneutralize(x, g)	x cross-sectionally demeaned within groups g (subindustries, industries, etc.)

[7]:
```
def rank(df):
    """Return the cross-sectional percentile rank

     Args:
         :param df: tickers in columns, sorted dates in rows.

     Returns:
         pd.DataFrame: the ranked values
     """
    return df.rank(axis=1, pct=True)
```

[8]:
```
def scale(df):
    """
    Scaling time serie.
    :param df: a pandas DataFrame.
    :param k: scaling factor.
    :return: a pandas DataFrame rescaled df such that sum(abs(df)) = k
    """
    return df.div(df.abs().sum(axis=1), axis=0)
```

1.2.2 Operators

- abs(x), log(x), sign(x), power(x, a) = standard definitions
- same for the operators “+”, “-”, “*”, “/”, “>”, “<”, “==”, “||”, “x ? y : z”

[9]:
```
def log(df):
    return np.log1p(df)
```

[10]:
```
def sign(df):
    return np.sign(df)
```

[11]:
```
def power(df, exp):
    return df.pow(exp)
```

1.2.3 Time Series

Function	Definition
ts_{O}(x, d)	Operator O applied to the time-series for the past d days; non-integer number of days d is converted to floor(d)
ts_lag(x, d)	Value of x d days ago

Function	Definition
ts_delta(x, d)	Difference between the value of x today and d days ago
ts_weighted_mean(x, d)	Weighted moving average over the past d days with linearly decaying weights d, d – 1, …, 1 (rescaled to sum up to 1)
ts_sum(x, d)	Rolling sum over the past d days
ts_product(x, d)	Rolling product over the past d days
ts_stddev(x, d)	Moving standard deviation over the past d days
ts_rank(x, d)	Rank over the past d days
ts_min(x, d)	Rolling min over the past d days [alias: min(x, d)]
ts_max(x, d)	Rolling max over the past d days [alias: max(x, d)]
ts_argmax(x, d)	Day of ts_max(x, d)
ts_argmin(x, d)	Day of ts_min(x, d)
ts_correlation(x, y, d)	Correlation of x and y for the past d days
ts_covariance(x, y, d)	Covariance of x and y for the past d days

Pandas Implementation

[12]:
```python
def ts_lag(df: pd.DataFrame, t: int = 1) -> pd.DataFrame:
    """Return the lagged values t periods ago.

    Args:
        :param df: tickers in columns, sorted dates in rows.
        :param t: lag

    Returns:
        pd.DataFrame: the lagged values
    """
    return df.shift(t)
```

[13]:
```python
def ts_delta(df, period=1):
    """
    Wrapper function to estimate difference.
    :param df: a pandas DataFrame.
    :param period: the difference grade.
    :return: a pandas DataFrame with today's value minus the value 'period'␣
 ↪days ago.
    """
    return df.diff(period)
```

[14]:
```python
def ts_sum(df: pd.DataFrame, window: int = 10) -> pd.DataFrame:
    """Computes the rolling ts_sum for the given window size.
```

```
    Args:
        df (pd.DataFrame): tickers in columns, dates in rows.
        window      (int): size of rolling window.

    Returns:
        pd.DataFrame: the ts_sum over the last 'window' days.
    """
    return df.rolling(window).sum()
```

[15]:
```
def ts_mean(df, window=10):
    """Computes the rolling mean for the given window size.

    Args:
        df (pd.DataFrame): tickers in columns, dates in rows.
        window      (int): size of rolling window.

    Returns:
        pd.DataFrame: the mean over the last 'window' days.
    """
    return df.rolling(window).mean()
```

[16]:
```
def ts_weighted_mean(df, period=10):
    """
    Linear weighted moving average implementation.
    :param df: a pandas DataFrame.
    :param period: the LWMA period
    :return: a pandas DataFrame with the LWMA.
    """
    return (df.apply(lambda x: WMA(x, timeperiod=period)))
```

[17]:
```
def ts_std(df, window=10):
    """
    Wrapper function to estimate rolling standard deviation.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series min over the past 'window'␣
 ↪days.
    """
    return (df
            .rolling(window)
            .std())
```

[18]:
```
def ts_rank(df, window=10):
    """
    Wrapper function to estimate rolling rank.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
```

```
    :return: a pandas DataFrame with the time-series rank over the past window␣
↪days.
    """
    return (df
            .rolling(window)
            .apply(lambda x: x.rank().iloc[-1]))
```

[19]:
```
def ts_product(df, window=10):
    """
    Wrapper function to estimate rolling ts_product.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series ts_product over the past␣
↪'window' days.
    """
    return (df
            .rolling(window)
            .apply(np.prod))
```

[20]:
```
def ts_min(df, window=10):
    """
    Wrapper function to estimate rolling min.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series min over the past 'window'␣
↪days.
    """
    return df.rolling(window).min()
```

[21]:
```
def ts_max(df, window=10):
    """
    Wrapper function to estimate rolling min.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series max over the past 'window'␣
↪days.
    """
    return df.rolling(window).max()
```

[22]:
```
def ts_argmax(df, window=10):
    """
    Wrapper function to estimate which day ts_max(df, window) occurred on
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: well.. that :)
    """
    return df.rolling(window).apply(np.argmax).add(1)
```

[23]:
```
def ts_argmin(df, window=10):
    """
    Wrapper function to estimate which day ts_min(df, window) occurred on
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: well.. that :)
    """
    return (df.rolling(window)
            .apply(np.argmin)
            .add(1))
```

[24]:
```
def ts_corr(x, y, window=10):
    """
    Wrapper function to estimate rolling correlations.
    :param x, y: pandas DataFrames.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series min over the past 'window'␣
 ↪days.
    """
    return x.rolling(window).corr(y)
```

[25]:
```
def ts_cov(x, y, window=10):
    """
    Wrapper function to estimate rolling covariance.
    :param df: a pandas DataFrame.
    :param window: the rolling window.
    :return: a pandas DataFrame with the time-series min over the past 'window'␣
 ↪days.
    """
    return x.rolling(window).cov(y)
```

1.3 Load Data

1.3.1 500 most-traded stocks

[26]:
```
ohlcv = ['open', 'high', 'low', 'close', 'volume']
data = (pd.read_hdf('data.h5', 'data/top500')
        .loc[:, ohlcv + ['ret_01', 'sector', 'ret_fwd']]
        .rename(columns={'ret_01': 'returns'})
        .sort_index())
```

[27]:
```
adv20 = data.groupby('ticker').rolling(20).volume.mean().reset_index(0,␣
 ↪drop=True)
```

[28]:
```
data = data.assign(adv20=adv20)
```

[29]:
```
data = data.join(data.groupby('date')[ohlcv].rank(axis=1, pct=True),␣
↪rsuffix='_rank')
```

[30]:
```
data.info(null_counts=True)
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 1255093 entries, ('A', Timestamp('2007-01-04 00:00:00')) to ('ZION',
Timestamp('2016-12-29 00:00:00'))
Data columns (total 14 columns):
 #   Column       Non-Null Count    Dtype
---  ------       --------------    -----
 0   open         1255093 non-null  float64
 1   high         1255093 non-null  float64
 2   low          1255093 non-null  float64
 3   close        1255093 non-null  float64
 4   volume       1255093 non-null  float64
 5   returns      1254593 non-null  float64
 6   sector       1255093 non-null  float64
 7   ret_fwd      1255093 non-null  float64
 8   adv20        0 non-null        float64
 9   open_rank    1255093 non-null  float64
 10  high_rank    1255093 non-null  float64
 11  low_rank     1255093 non-null  float64
 12  close_rank   1255093 non-null  float64
 13  volume_rank  1255093 non-null  float64
dtypes: float64(14)
memory usage: 171.9+ MB
```

[31]:
```
# data.to_hdf('factors.h5', 'data')
```

1.3.2 Input Data

Variable	Description
returns	daily close-to-close returns
open, close, high, low, volume	standard definitions for daily price and volume data
vwap	daily volume-weighted average price
cap	market cap
adv{d}	average daily dollar volume for the past d days

Variable	Description
IndClass	a generic placeholder for a binary industry classification such as GICS, BICS, NAICS, SIC, etc., in indneutralize(x, IndClass.level), where level = sector, industry, subindustry, etc. Multiple IndClass in the same alpha need not correspond to the same industry classification.

[32]:
```
o = data.open.unstack('ticker')
h = data.high.unstack('ticker')
l = data.low.unstack('ticker')
c = data.close.unstack('ticker')
v = data.volume.unstack('ticker')
vwap = o.add(h).add(l).add(c).div(4)
adv20 = v.rolling(20).mean()
r = data.returns.unstack('ticker')
```

1.4 Evaluate Alphas

[33]:
```
alphas = data[['returns', 'ret_fwd']].copy()
mi,ic = {}, {}
```

[34]:
```
def get_mutual_info_score(returns, alpha, n=100000):
    df = pd.DataFrame({'y': returns, 'alpha': alpha}).dropna().sample(n=n)
    return mutual_info_regression(y=df.y, X=df[['alpha']])[0]
```

1.5 Alpha 001

```
rank(ts_argmax(power(((returns < 0) ? ts_std(returns, 20) : close), 2.), 5))
```

[32]:
```
def alpha001(c, r):
    """(rank(ts_argmax(power(((returns < 0)
        ? ts_std(returns, 20)
        : close), 2.), 5)) -0.5)"""
    c[r < 0] = ts_std(r, 20)
    return (rank(ts_argmax(power(c, 2), 5)).mul(-.5)
            .stack().swaplevel())
```

[33]:
```
alpha = 1
```

[34]:
```
%%time
alphas[f'{alpha:03}'] = alpha001(c, r)
```

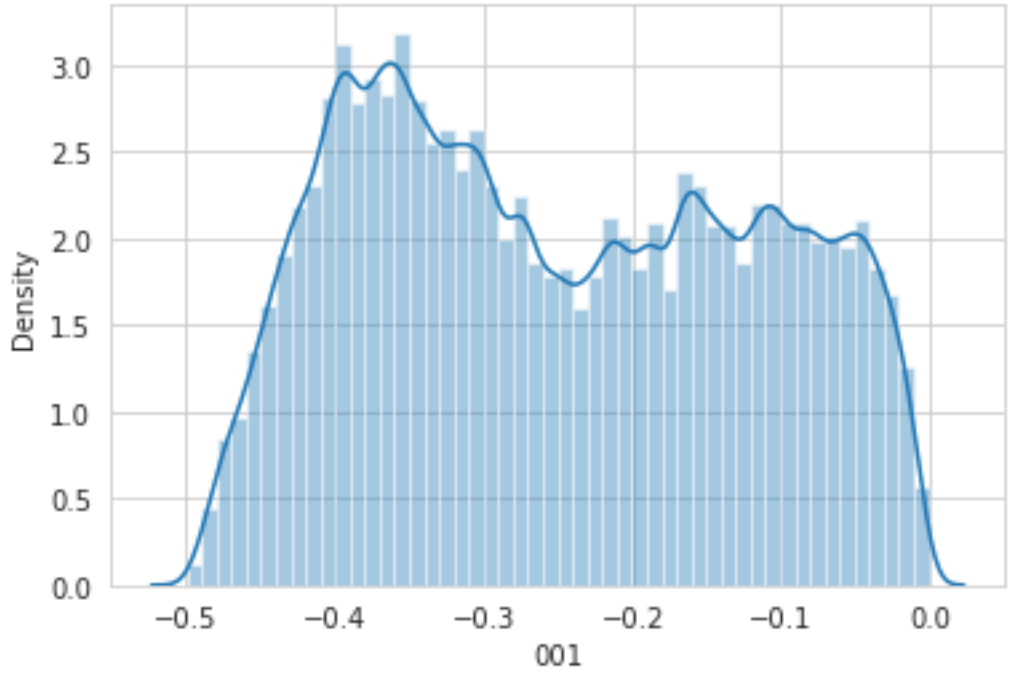
```
CPU times: user 1min 57s, sys: 334 ms, total: 1min 57s
Wall time: 1min 58s
```

[35]:
```
alphas.info()
```

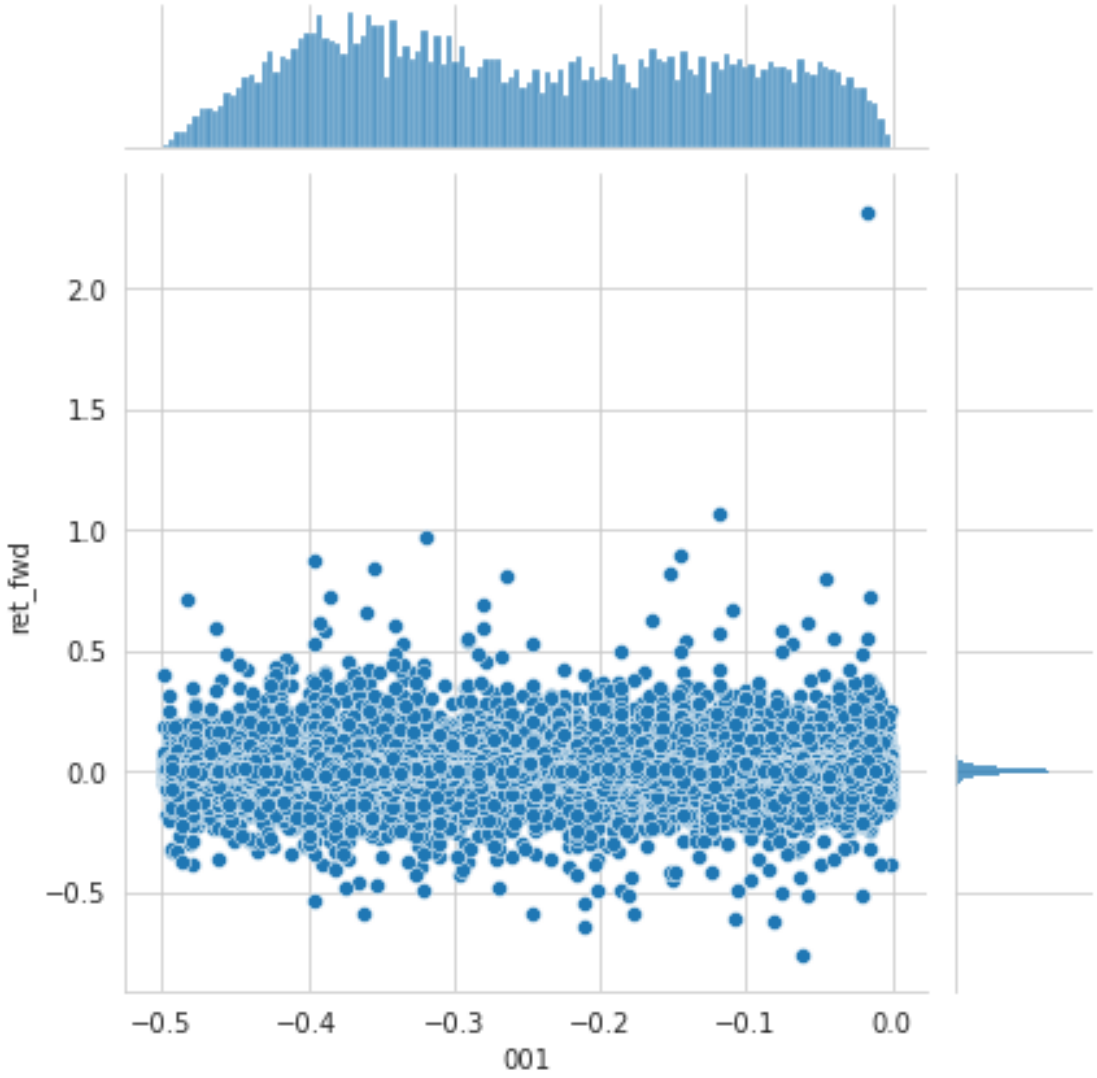
```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 1255093 entries, ('A', Timestamp('2007-01-04 00:00:00')) to ('ZION',
Timestamp('2016-12-29 00:00:00'))
Data columns (total 3 columns):
 #   Column   Non-Null Count    Dtype
---  ------   --------------    -----
 0   returns  1254593 non-null  float64
 1   ret_fwd  1255093 non-null  float64
 2   001      1243849 non-null  float64
dtypes: float64(3)
memory usage: 66.5+ MB
```

[36]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[37]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[38]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas)
```



[39]:
```
mi[1] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[1]
```

[39]: 0.01888595802975246

1.6 Alpha 002

correlation(rank(delta(log(volume), 2)), rank(((close - open) / open)), 6))

[40]:
```
def alpha002(o, c, v):
    """(-1 * ts_corr(rank(ts_delta(log(volume), 2)), rank(((close - open) /␣
↪open)), 6))"""
    s1 = rank(ts_delta(log(v), 2))
    s2 = rank((c / o) - 1)
```

```
    alpha = -ts_corr(s1, s2, 6)
    return alpha.stack('ticker').swaplevel().replace([-np.inf, np.inf], np.nan)
```

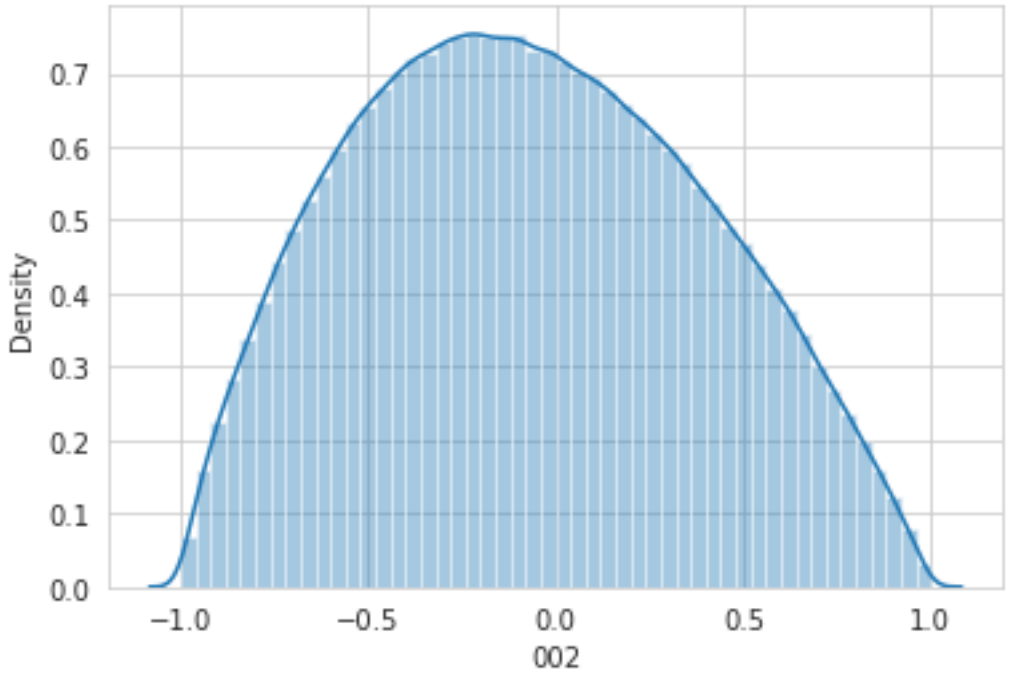
[41]:
```
alpha = 2
```

[42]:
```
%%time
alphas[f'{alpha:03}'] = alpha002(o, c, v)
```

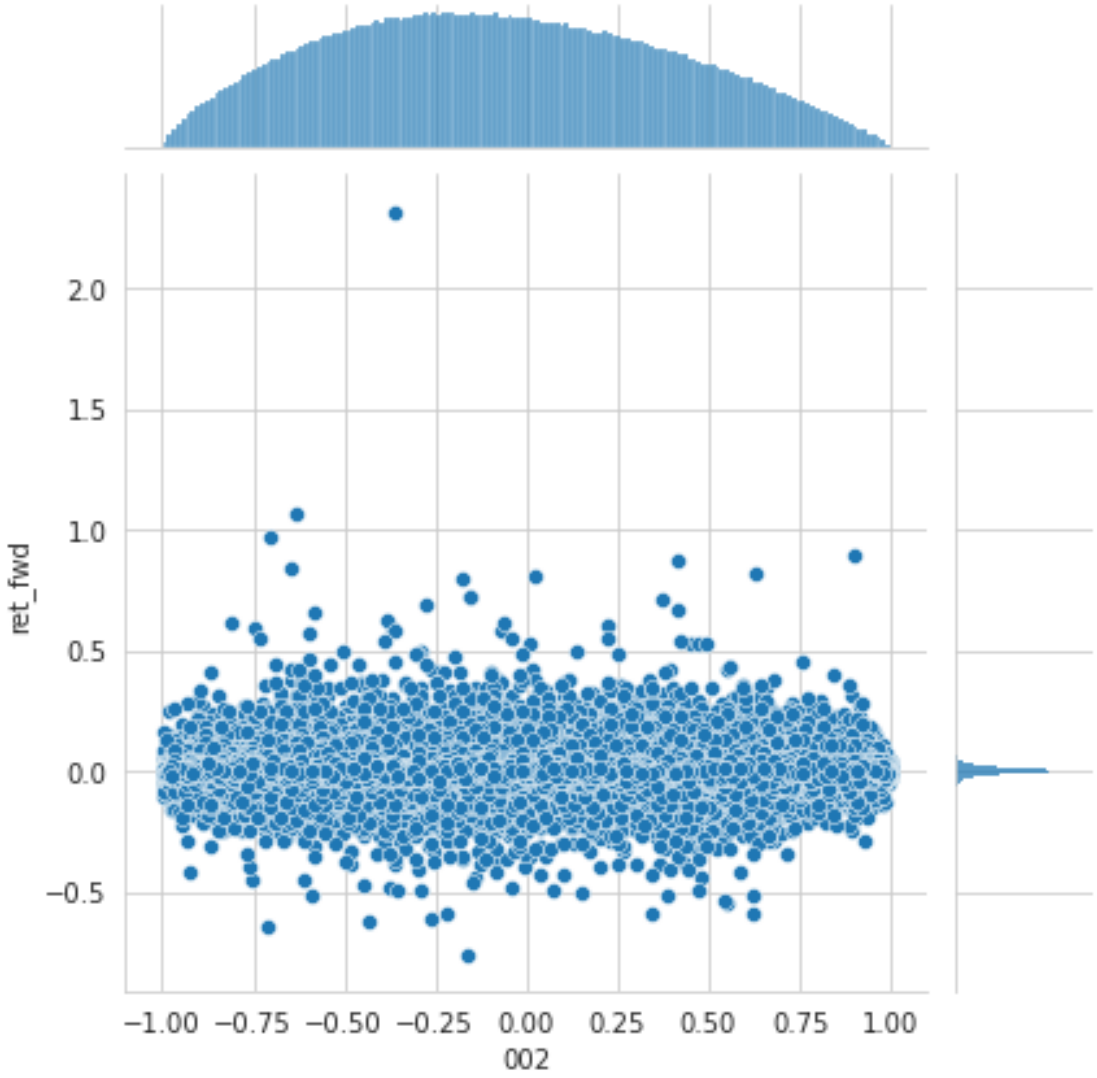
```
CPU times: user 3.86 s, sys: 28 ms, total: 3.88 s
Wall time: 3.84 s
```

[43]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[44]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[45]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas)
```



[46]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[2]
```

[46]: 0.0012399516229262275

1.7 Alpha 003

(-1 * correlation(rank(open), rank(volume), 10))

[47]:
```
def alpha003(o, v):
    """(-1 * ts_corr(rank(open), rank(volume), 10))"""

    return (-ts_corr(rank(o), rank(v), 10)
            .stack('ticker')
```

```
            .swaplevel()
            .replace([-np.inf, np.inf], np.nan))
```

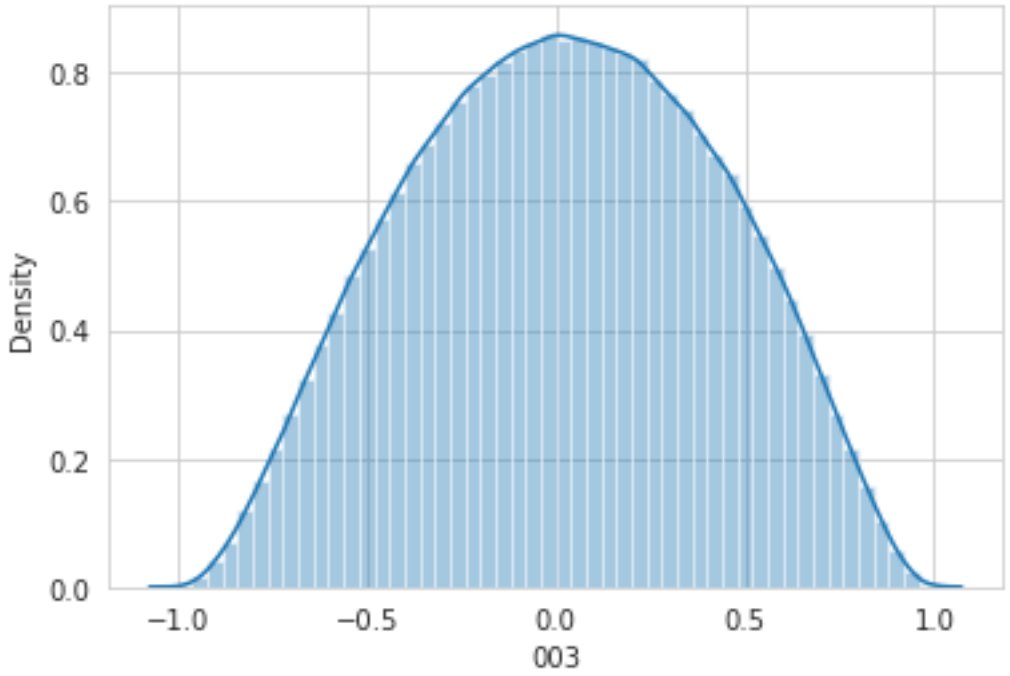
[48]:
```
alpha = 3
```

[49]:
```
%%time
alphas[f'{alpha:03}'] = alpha003(o, v)
```

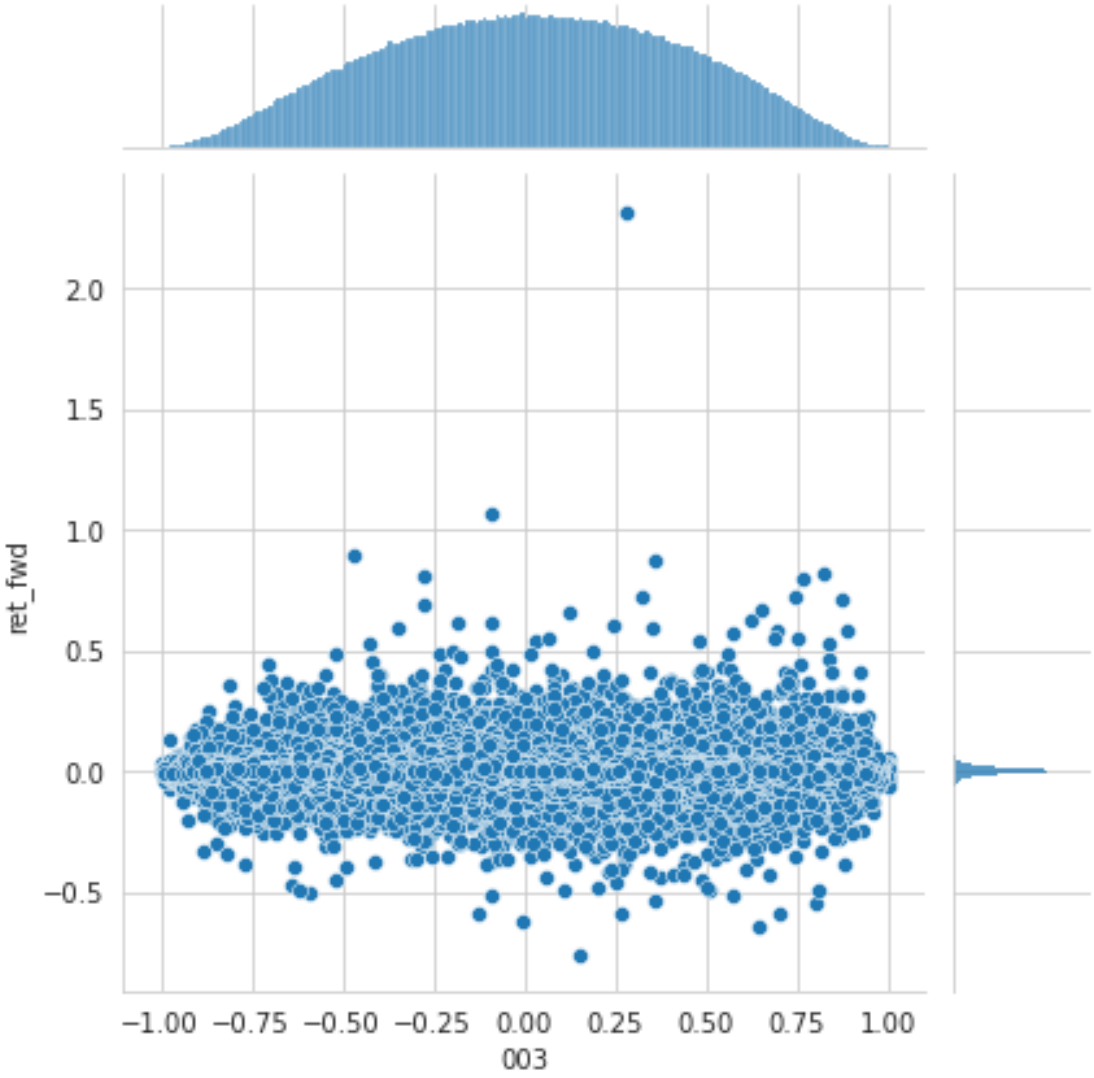
```
CPU times: user 4.03 s, sys: 112 ms, total: 4.14 s
Wall time: 4.17 s
```

[50]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[51]:
```
sns.distplot(alphas[f'{alpha:03}'].clip(lower=-1));
```



[52]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[53]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[53]: 0

1.8 Alpha 004

(-1 * Ts_Rank(rank(low), 9))

[54]:
```
def alpha004(l):
    """(-1 * Ts_Rank(rank(low), 9))"""
    return (-ts_rank(rank(l), 9)
            .stack('ticker')
            .swaplevel())
```

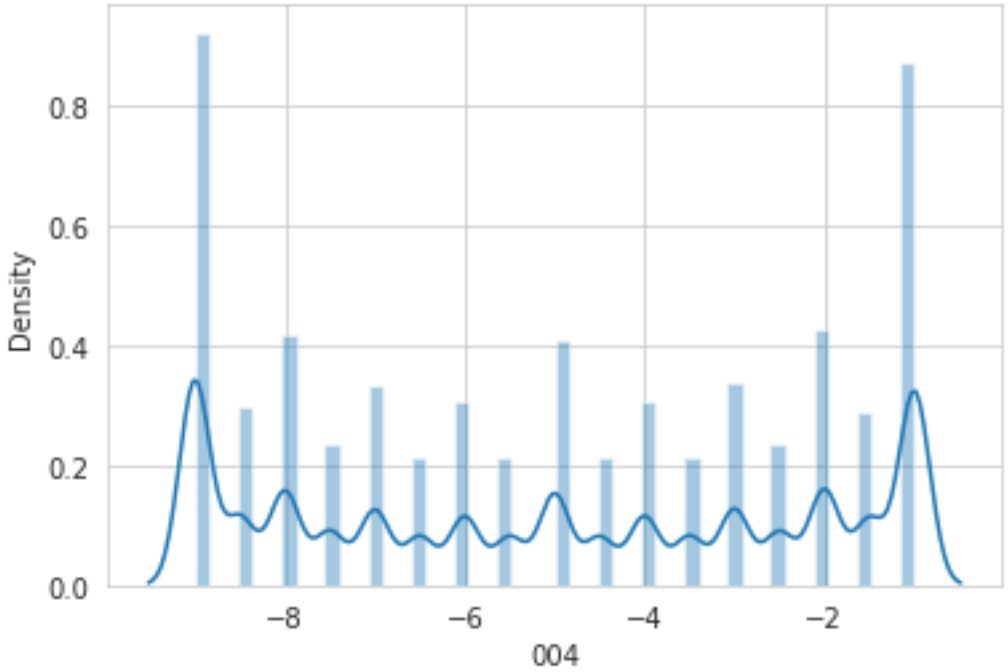
[55]:
```
alpha = 4
```

[56]:
```
%%time
alphas[f'{alpha:03}'] = alpha004(1)
```

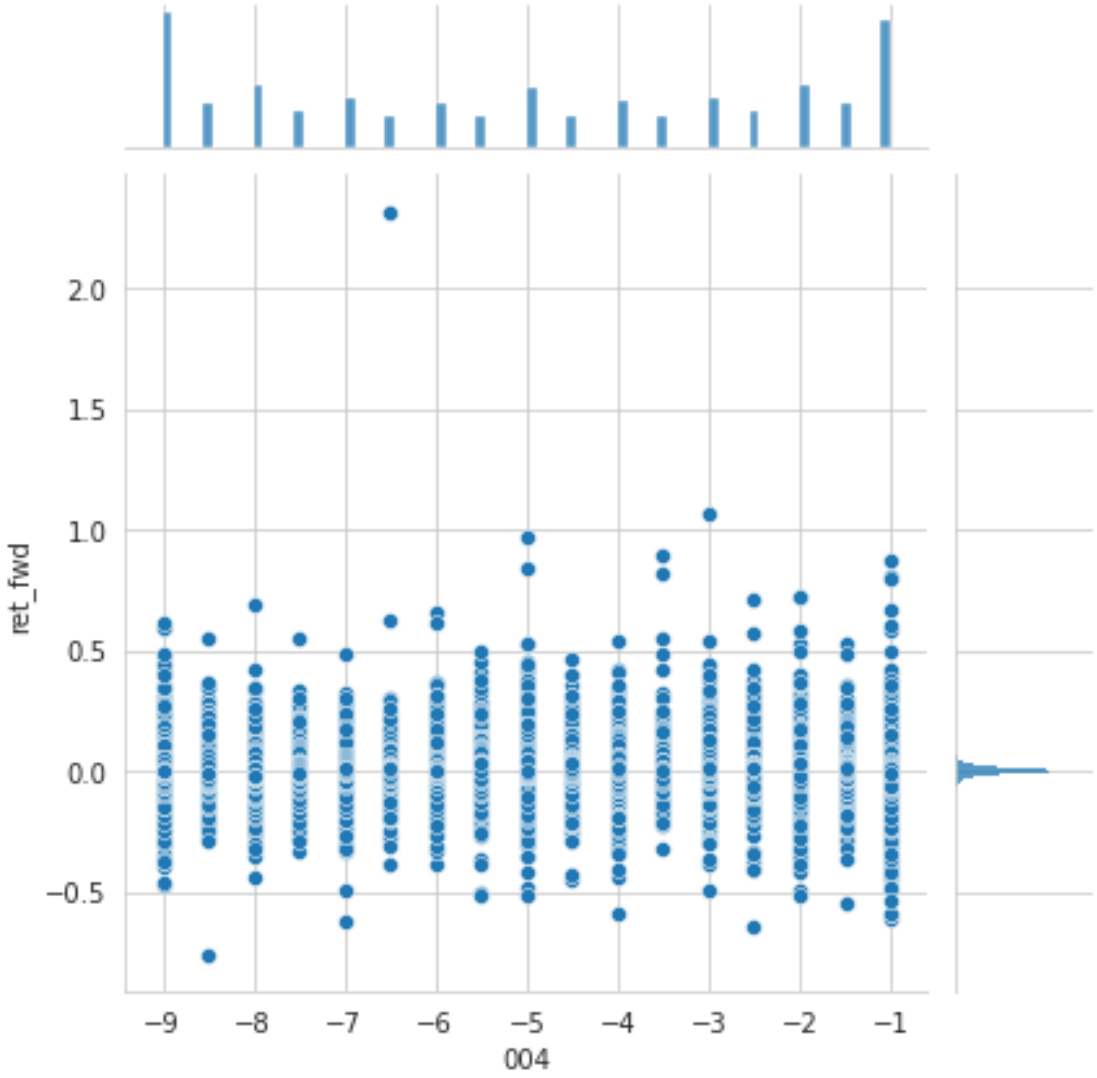
```
CPU times: user 3min 3s, sys: 62.4 ms, total: 3min 3s
Wall time: 3min 3s
```

[57]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[58]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[59]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[60]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[60]: 0

1.9 Alpha 005

Very roughly approximating wvap as average of OHLC.

`(rank((open - (sum(vwap, 10) / 10))) * (-1 * abs(rank((close - vwap)))))`

[61]:
```
def alpha005(o, vwap, c):
    """(rank((open - ts_mean(vwap, 10))) * (-1 * abs(rank((close - vwap)))))"""
    return (rank(o.sub(ts_mean(vwap, 10)))
```

```
            .mul(rank(c.sub(vwap)).mul(-1).abs())
            .stack('ticker')
            .swaplevel())
```

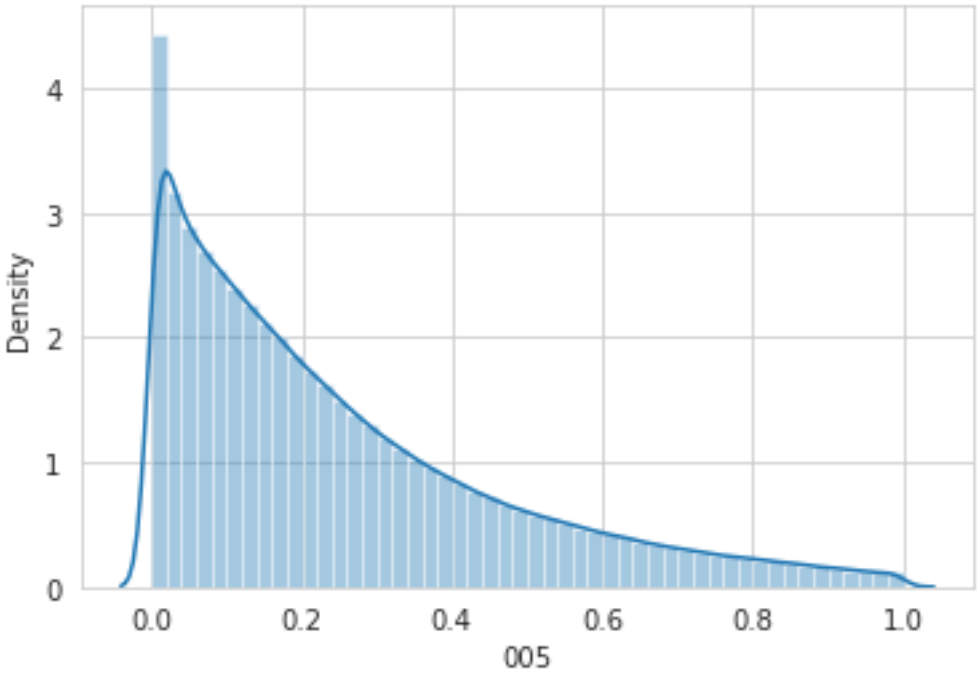
[62]:
```
alpha = 5
```

[63]:
```
%%time
alphas[f'{alpha:03}'] = alpha005(o, vwap, c)
```

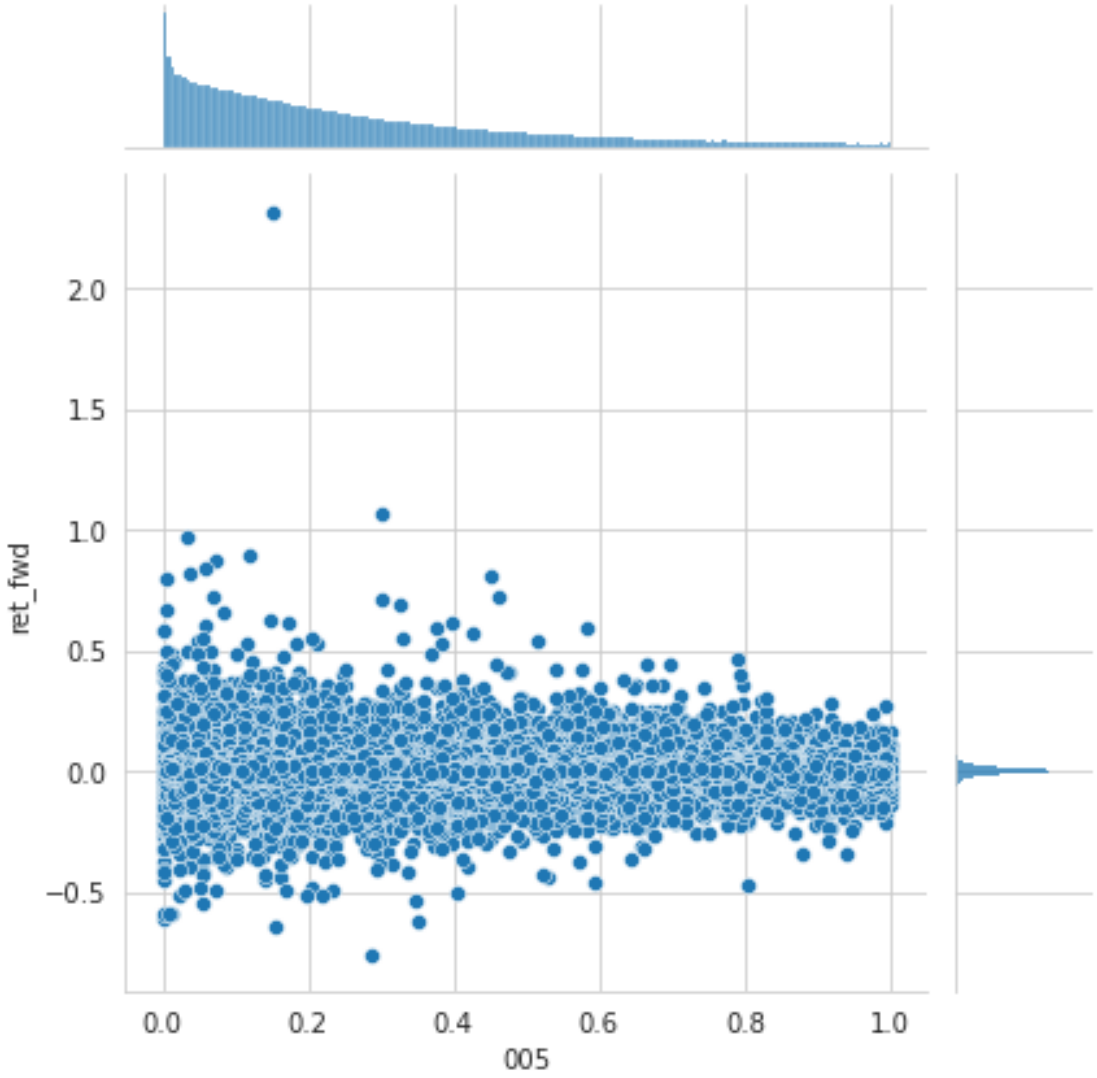
```
CPU times: user 2.21 s, sys: 12 ms, total: 2.22 s
Wall time: 2.18 s
```

[64]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[65]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[66]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[67]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[67]: 0

1.10 Alpha 006

-ts_corr(open, volume, 10)

[68]:
```
def alpha006(o, v):
    """(-ts_corr(open, volume, 10))"""
    return (-ts_corr(o, v, 10)
            .stack('ticker')
            .swaplevel())
```

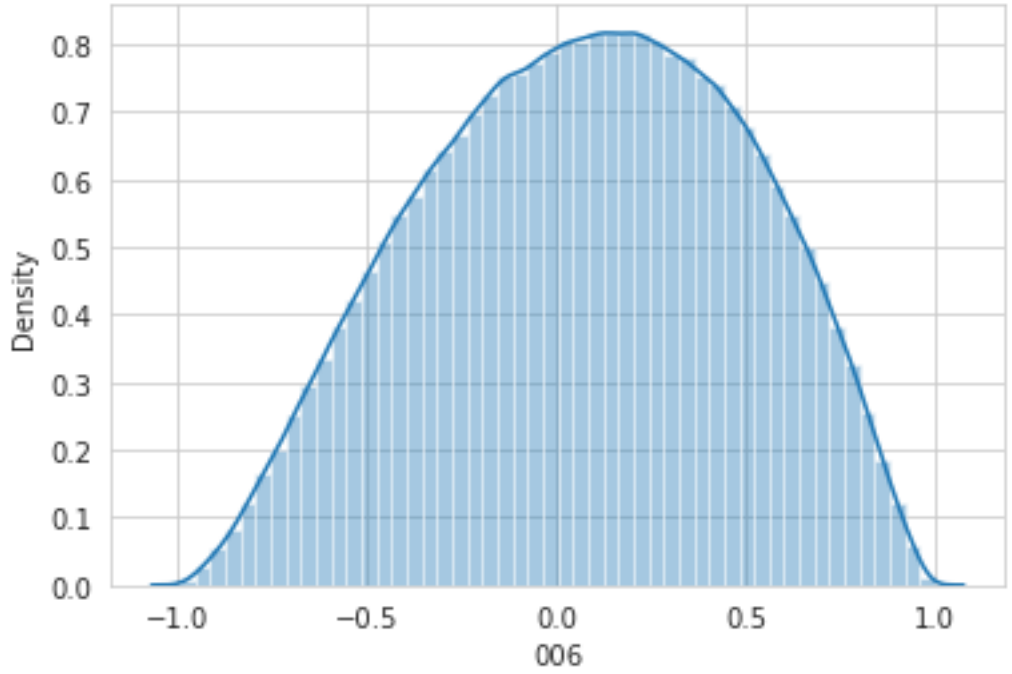
[69]:
```
alpha = 6
```

[70]:
```
%%time
alphas[f'{alpha:03}'] = alpha006(o, v)
```

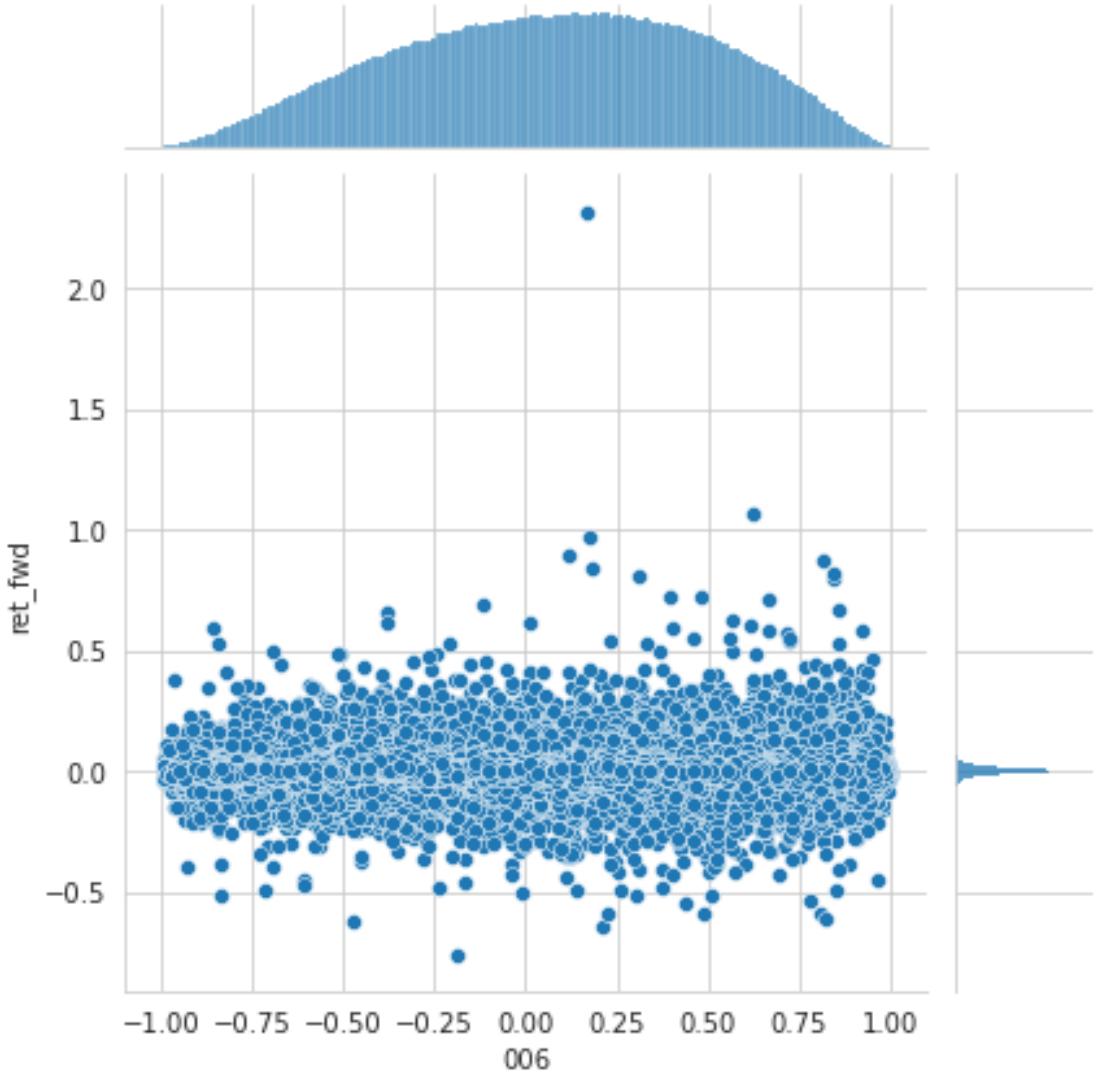
```
CPU times: user 3.54 s, sys: 48.2 ms, total: 3.59 s
Wall time: 3.56 s
```

[71]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[72]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[73]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[74]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[75]:
```
mi[alpha]
```

[75]:
```
0.0026892751534788317
```

1.11 Alpha 007

```
(adv20 < volume)
? ((-1 * ts_rank(abs(ts_delta(close, 7)), 60)) * sign(ts_delta(close, 7)))
: -1
```

[76]:
```
def alpha007(c, v, adv20):
    """(adv20 < volume)
```

```
        ? ((-ts_rank(abs(ts_delta(close, 7)), 60)) * sign(ts_delta(close, 7)))
        : -1
    """

    delta7 = ts_delta(c, 7)
    return (-ts_rank(abs(delta7), 60)
            .mul(sign(delta7))
            .where(adv20<v, -1)
            .stack('ticker')
            .swaplevel())
```

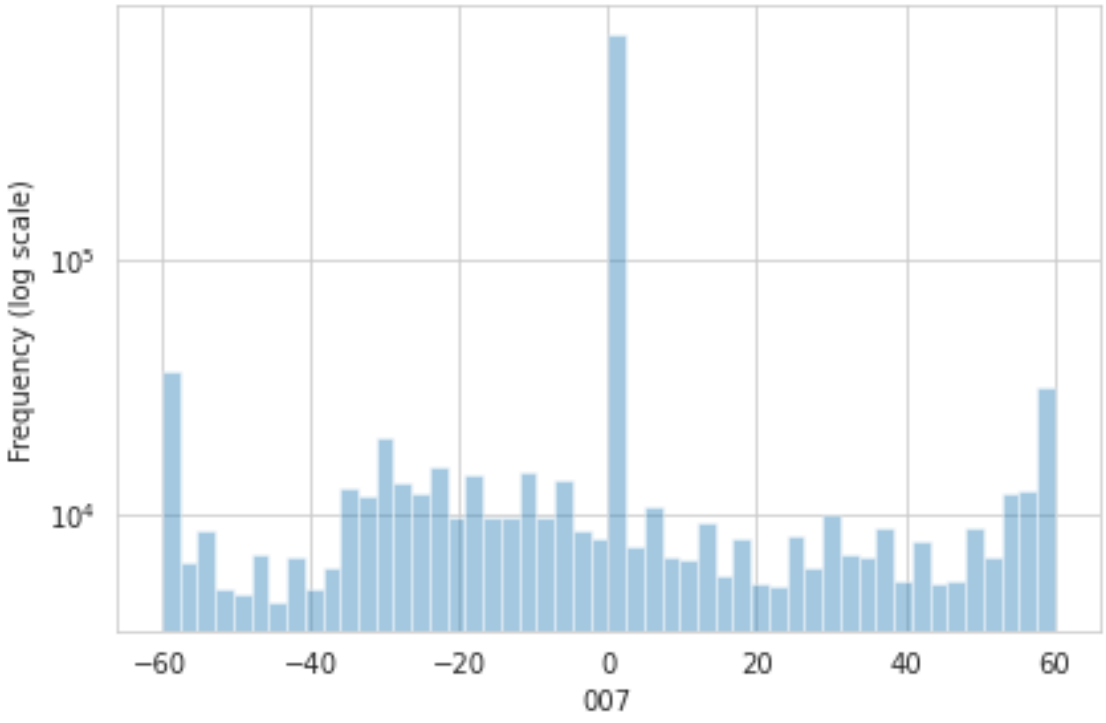
[77]:
```
alpha = 7
```

[78]:
```
%%time
alphas[f'{alpha:03}'] = alpha007(c, v, adv20)
```

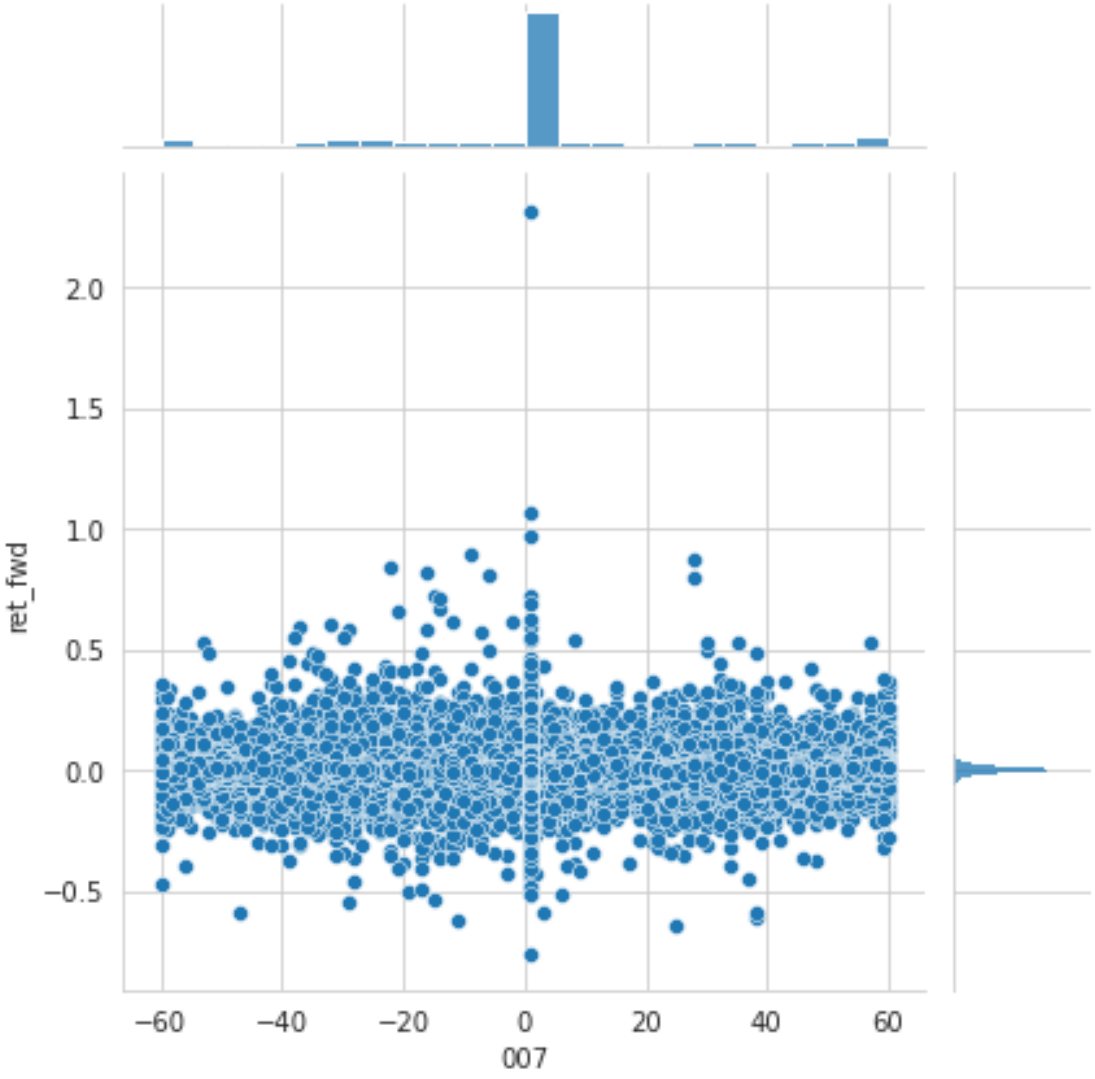
```
CPU times: user 3min 1s, sys: 83.5 ms, total: 3min 1s
Wall time: 3min 1s
```

[79]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[80]:
```
ax = sns.distplot(alphas[f'{alpha:03}'], kde=False)
ax.set_yscale('log')
ax.set_ylabel('Frequency (log scale)')
plt.tight_layout();
```



[81]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[82]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[83]:
```
# mi[alpha]
```

1.12 Alpha 008

```
-rank(((ts_sum(open, 5) * ts_sum(returns, 5)) - ts_lag((ts_sum(open, 5) * ts_sum(returns, 5)),
```

[84]:
```
def alpha008(o, r):
    """-rank(((ts_sum(open, 5) * ts_sum(returns, 5)) -
        ts_lag((ts_sum(open, 5) * ts_sum(returns, 5)),10)))
    """
    return (-(rank(((ts_sum(o, 5) * ts_sum(r, 5)) -
                    ts_lag((ts_sum(o, 5) * ts_sum(r, 5)), 10))))
            .stack('ticker')
             .swaplevel())
```

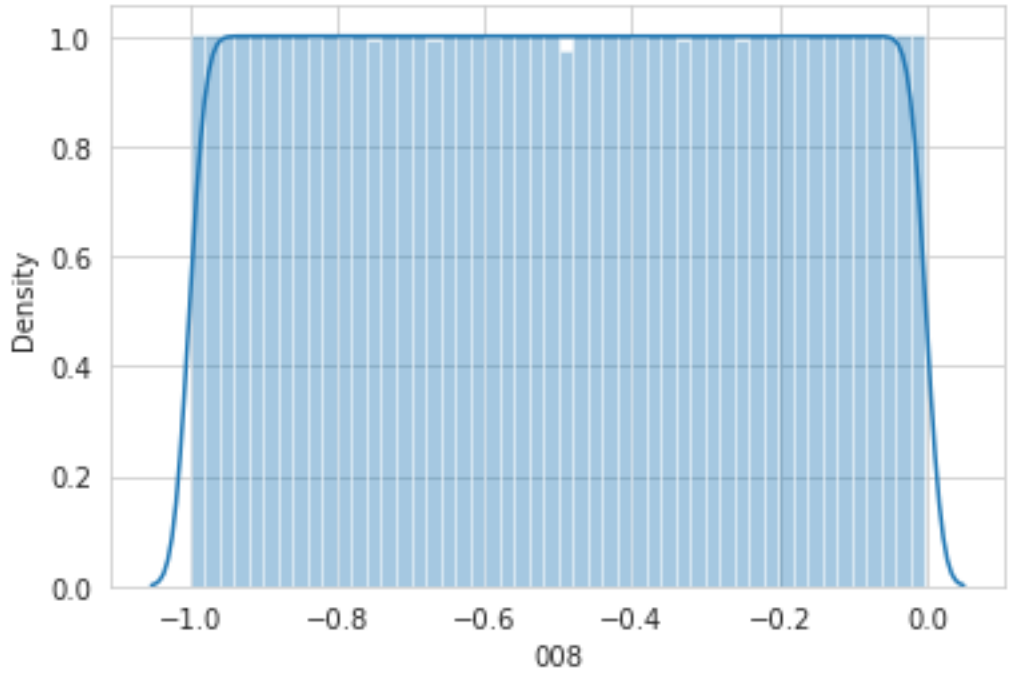
[85]:
```
alpha = 8
```

[86]:
```
%%time
alphas[f'{alpha:03}'] = alpha008(o, r)
```

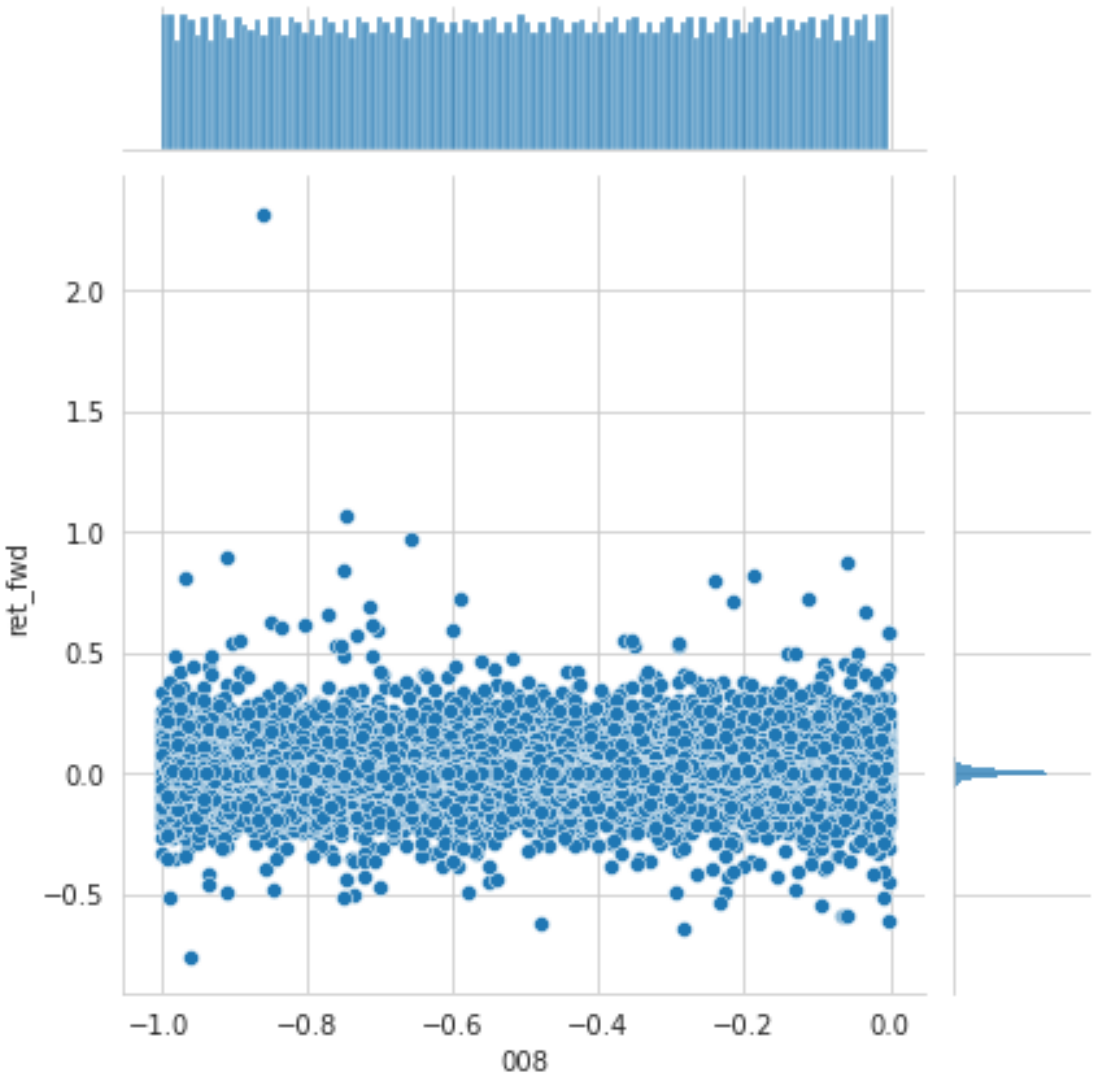
```
CPU times: user 2.15 s, sys: 12 ms, total: 2.16 s
Wall time: 2.13 s
```

[87]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[88]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[89]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[90]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[91]:
```
mi[alpha]
```

[91]: 0

1.13 Alpha 009

```
(0 < ts_min(ts_delta(close, 1), 5)) ? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 5) < 0)
? ts_delta(close, 1) : (-1 * ts_delta(close, 1)))
```

[92]:
```
def alpha009(c):
    """(0 < ts_min(ts_delta(close, 1), 5)) ? ts_delta(close, 1)
    : ((ts_max(ts_delta(close, 1), 5) < 0)
    ? ts_delta(close, 1) : (-1 * ts_delta(close, 1)))
    """
    close_diff = ts_delta(c, 1)
    alpha = close_diff.where(ts_min(close_diff, 5) > 0,
                             close_diff.where(ts_max(close_diff, 5) < 0,
                                              -close_diff))
    return (alpha
            .stack('ticker')
            .swaplevel())
```

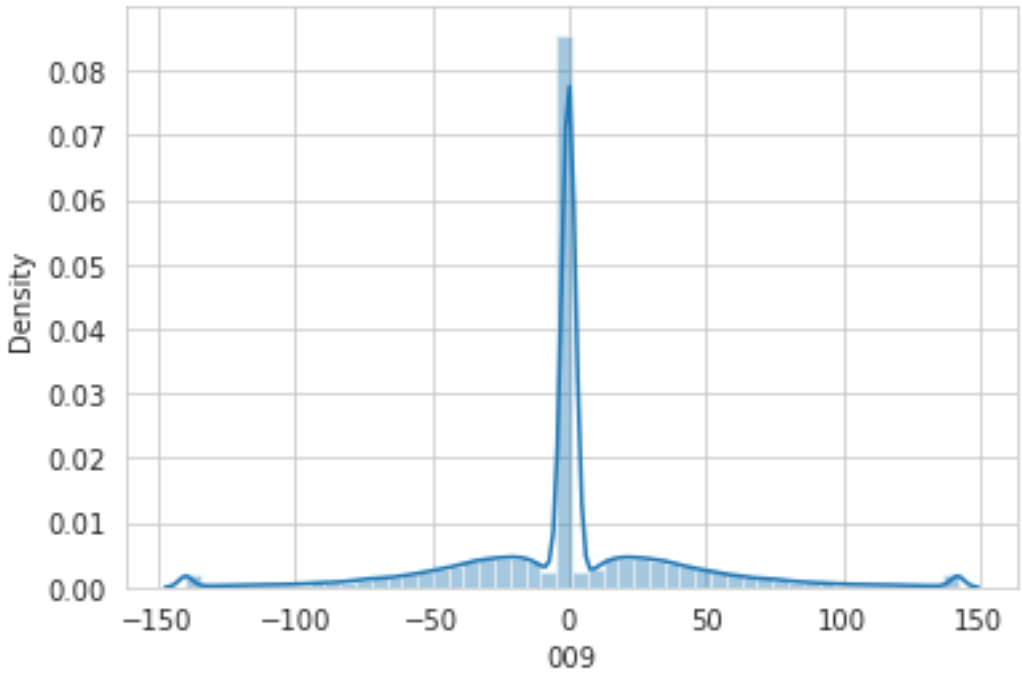
[93]:
```
alpha = 9
```

[94]:
```
%%time
alphas[f'{alpha:03}'] = alpha009(c)
```

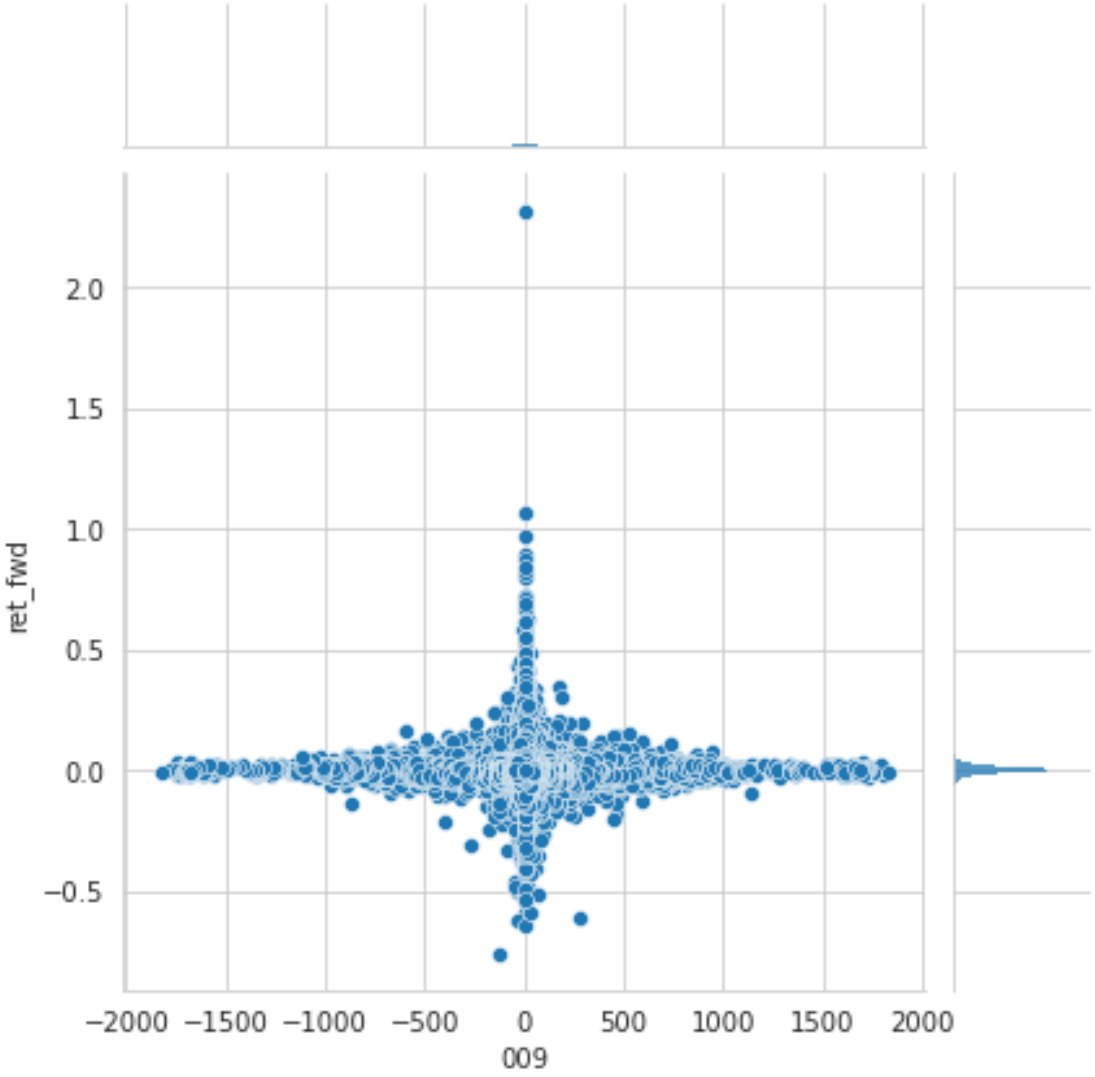
```
CPU times: user 2.01 s, sys: 20.1 ms, total: 2.03 s
Wall time: 2.01 s
```

[95]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[96]:
```
q = 0.01
sns.distplot(alphas[f'{alpha:03}'].clip(lower=alphas[f'{alpha:03}'].quantile(q),
                                        upper=alphas[f'{alpha:03}'].
 ↪quantile(1-q)));
```



[97]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[98]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[99]:
```
mi[alpha]
```

[99]:
```
0.022059908730502O1
```

[100]:
```
pd.Series(mi)
```

[100]:
```
1    0.018886
2    0.001240
3    0.000000
4    0.000000
5    0.000000
6    0.002689
8    0.000000
9    0.022060
dtype: float64
```

1.14 Alpha 010

```
rank(((0 < ts_min(ts_delta(close, 1), 4))
? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 4) < 0)
    ? ts_delta(close, 1)
    : (-1 * ts_delta(close, 1)))))
```

[101]:
```
def alpha010(c):
    """rank(((0 < ts_min(ts_delta(close, 1), 4))
        ? ts_delta(close, 1)
        : ((ts_max(ts_delta(close, 1), 4) < 0)
            ? ts_delta(close, 1)
            : (-1 * ts_delta(close, 1)))))
    """
    close_diff = ts_delta(c, 1)
    alpha = close_diff.where(ts_min(close_diff, 4) > 0,
                             close_diff.where(ts_min(close_diff, 4) > 0,
                                              -close_diff))

    return (rank(alpha)
            .stack('ticker')
            .swaplevel())
```

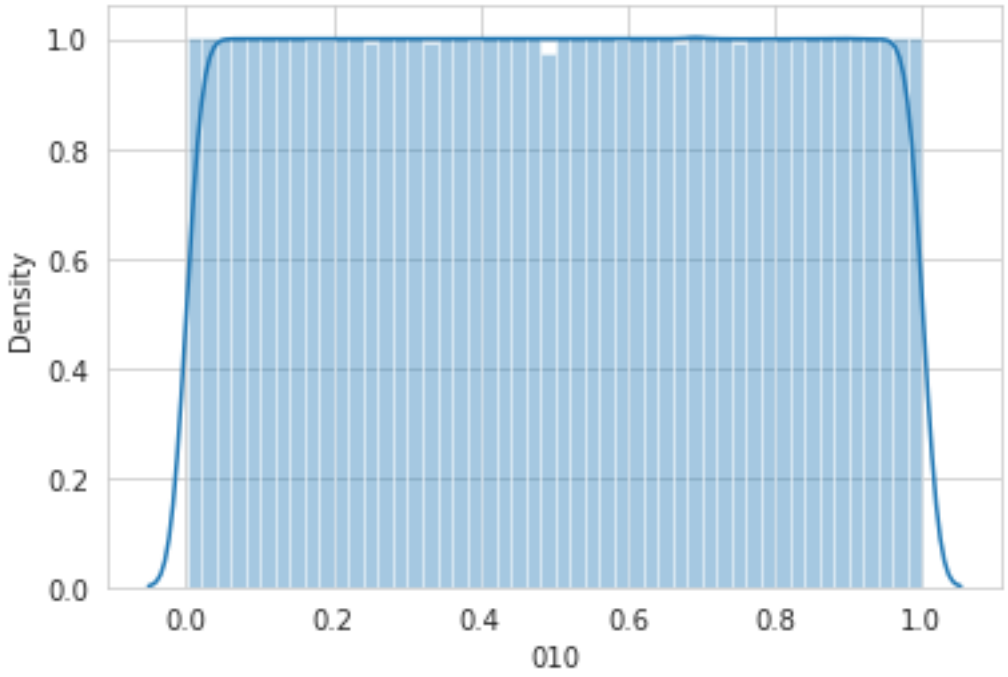
[102]:
```
alpha = 10
```

[103]:
```
%%time
alphas[f'{alpha:03}'] = alpha010(c)
```

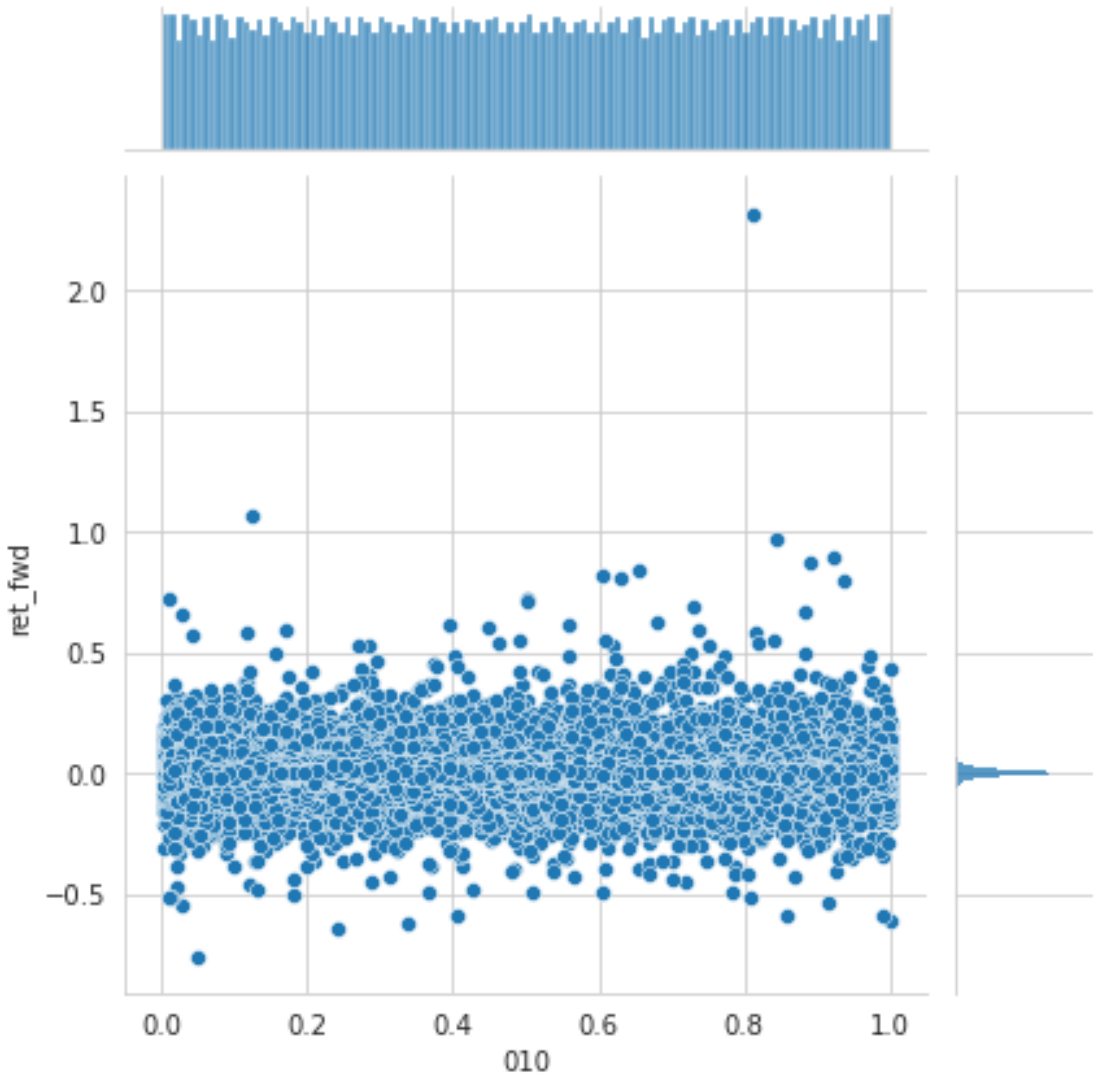
```
CPU times: user 2.67 s, sys: 24.1 ms, total: 2.7 s
Wall time: 2.67 s
```

[104]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[105]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[106]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[107]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[108]:
```
mi[alpha]
```

[108]: 0

[109]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.15 Alpha 011

```
((rank(ts_max((vwap - close), 3)) + rank(ts_min((vwap - close), 3))) *rank(ts_delta(volume, 3))
```

[110]:
```
def alpha011(c, vwap, v):
    """(rank(ts_max((vwap - close), 3)) +
        rank(ts_min(vwap - close), 3)) *
        rank(ts_delta(volume, 3))
        """
    return (rank(ts_max(vwap.sub(c), 3))
            .add(rank(ts_min(vwap.sub(c), 3)))
            .mul(rank(ts_delta(v, 3)))
            .stack('ticker')
            .swaplevel())
```

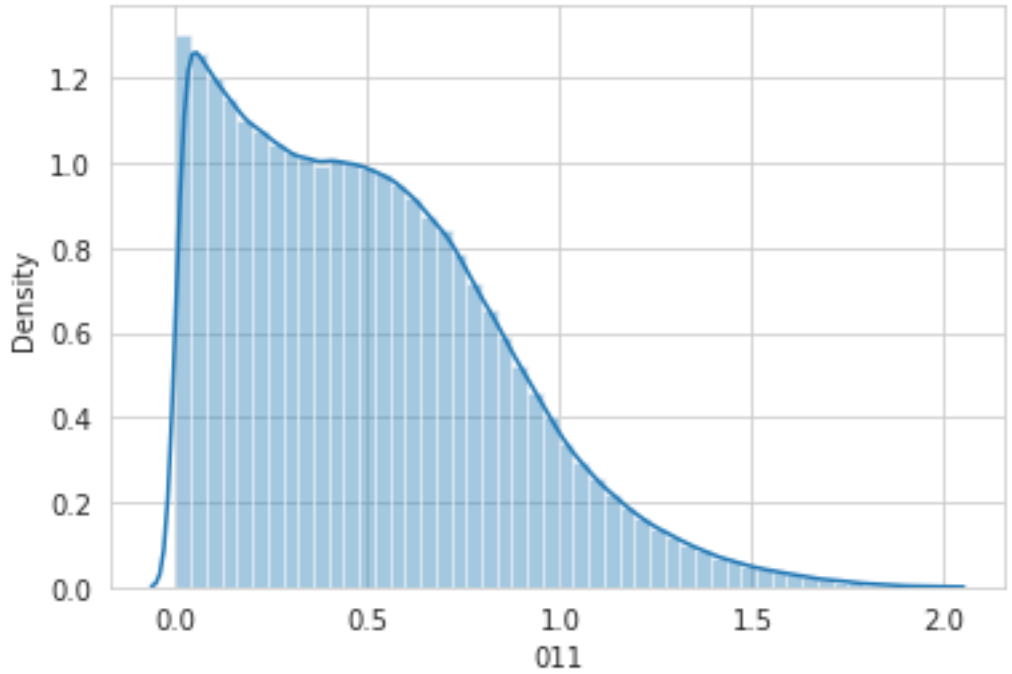
[111]:
```
alpha = 11
```

[112]:
```
%%time
alphas[f'{alpha:03}'] = alpha011(c, vwap, v)
```

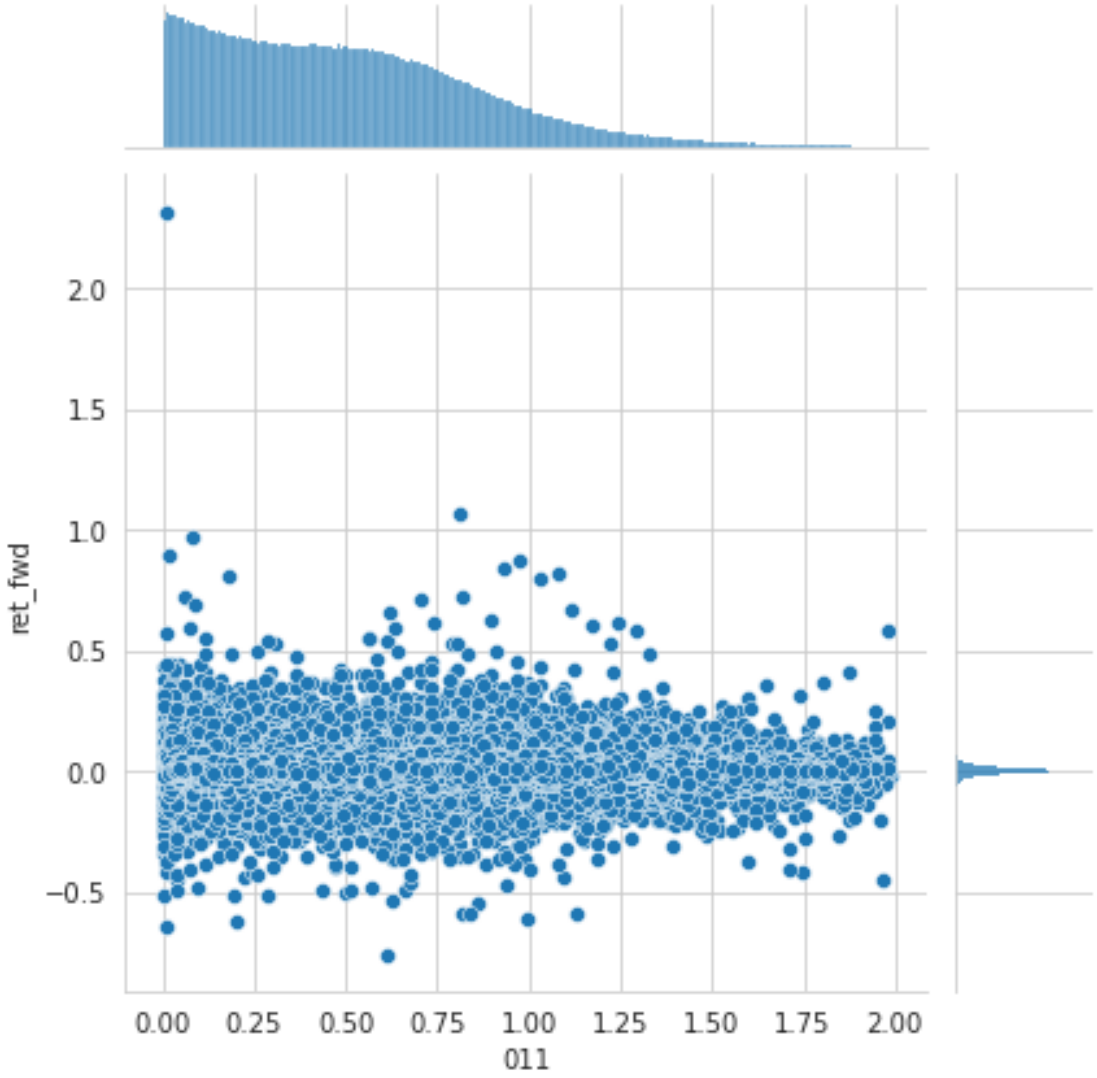
```
CPU times: user 2.48 s, sys: 64.2 ms, total: 2.55 s
Wall time: 2.49 s
```

[113]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[114]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[115]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[116]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[117]:
```
mi[alpha]
```

[117]: 0.0032785883763768453

1.16 Alpha 012

`sign(ts_delta(volume, 1)) * -ts_delta(close, 1)`

[118]:
```
def alpha012(v, c):
    """(sign(ts_delta(volume, 1)) *
            (-1 * ts_delta(close, 1)))
        """
```

```
    return (sign(ts_delta(v, 1)).mul(-ts_delta(c, 1))
            .stack('ticker')
            .swaplevel())
```

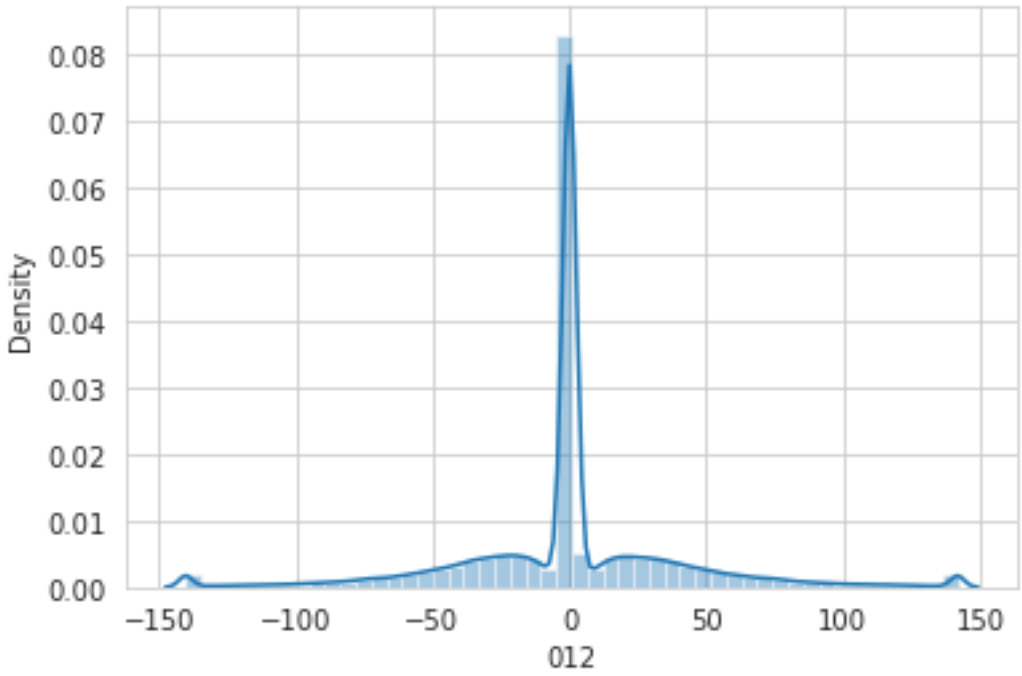
[119]:
```
alpha = 12
```

[120]:
```
%%time
alphas[f'{alpha:03}'] = alpha012(v, c)
```

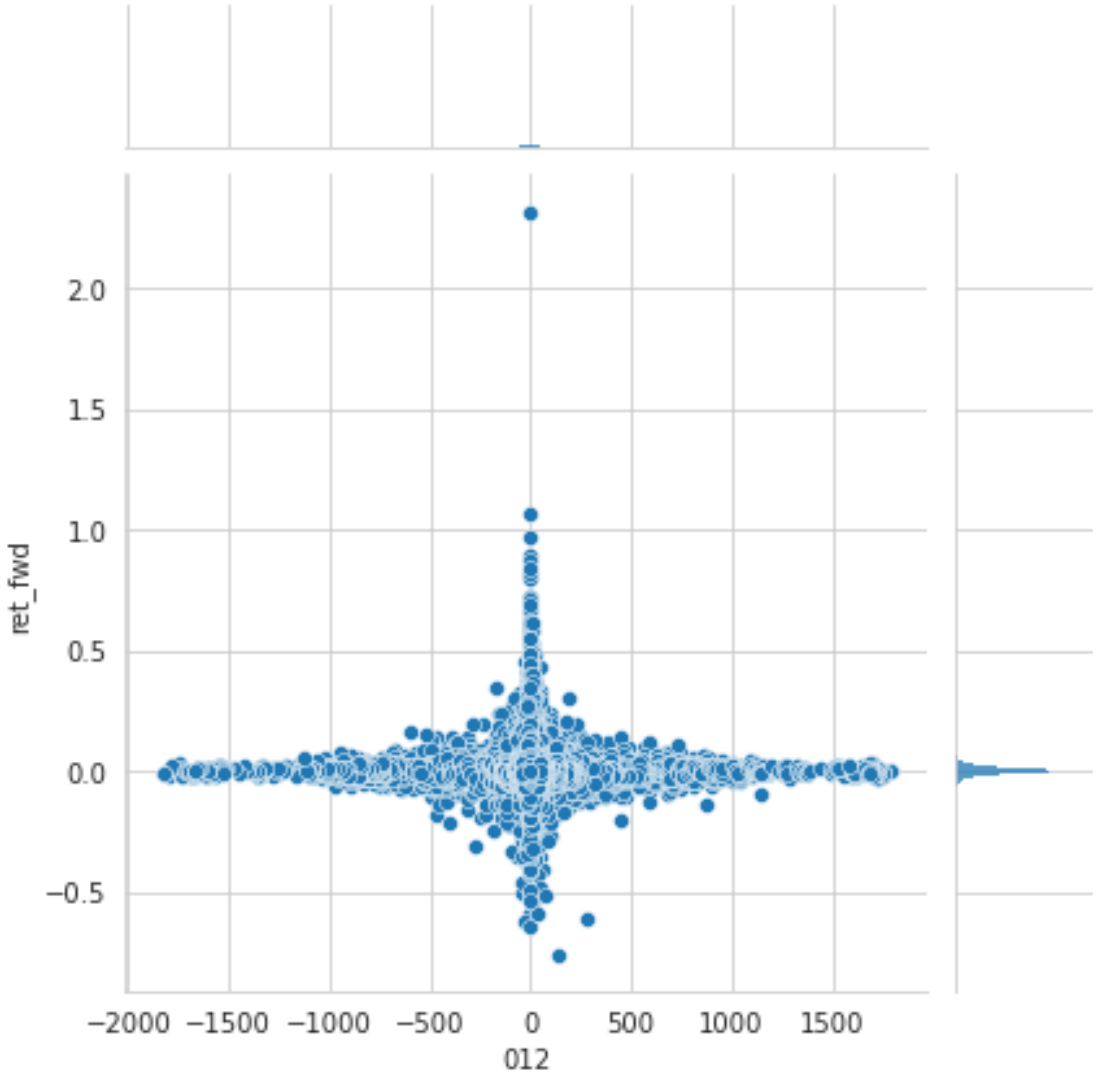
```
CPU times: user 2.03 s, sys: 8.03 ms, total: 2.04 s
Wall time: 2.03 s
```

[121]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[122]:
```
q = 0.01
sns.distplot(alphas[f'{alpha:03}'].clip(lower=alphas[f'{alpha:03}'].quantile(q),
                                        upper=alphas[f'{alpha:03}'].
 ↪quantile(1-q)));
```



[123]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[124]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[125]:
```
mi[alpha]
```

[125]: 0.015514105621370788

1.17 Alpha 013

-rank(ts_cov(rank(close), rank(volume), 5))

[126]:
```
def alpha013(c, v):
    """-rank(ts_cov(rank(close), rank(volume), 5))"""
    return (-rank(ts_cov(rank(c), rank(v), 5))
            .stack('ticker')
```

```
            .swaplevel())
```

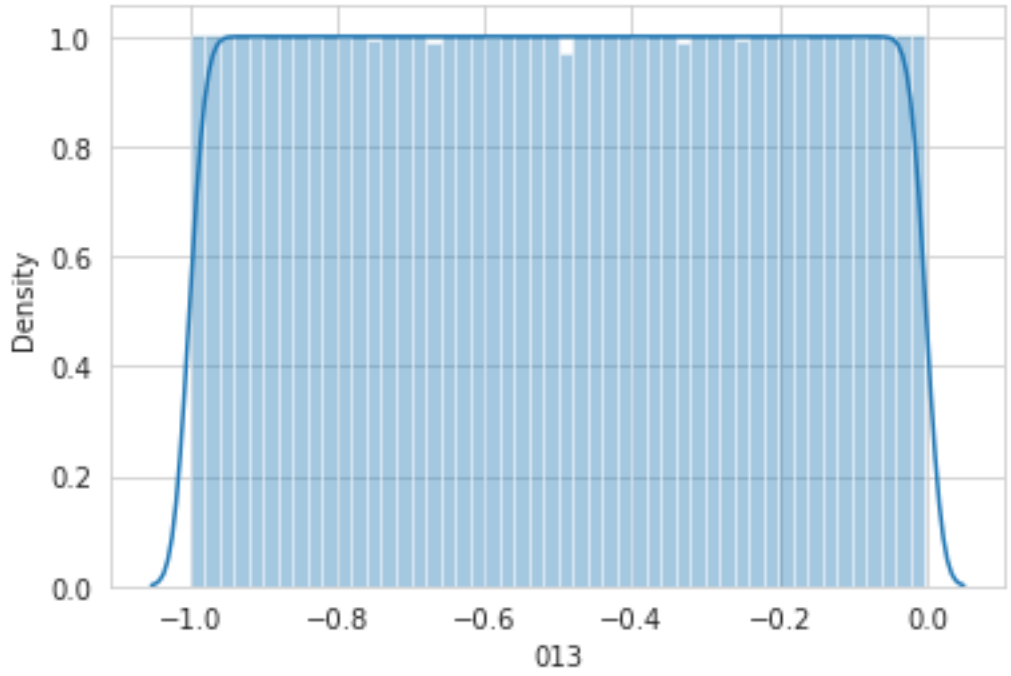
[127]:
```
alpha = 13
```

[128]:
```
%%time
alphas[f'{alpha:03}'] = alpha013(c, v)
```

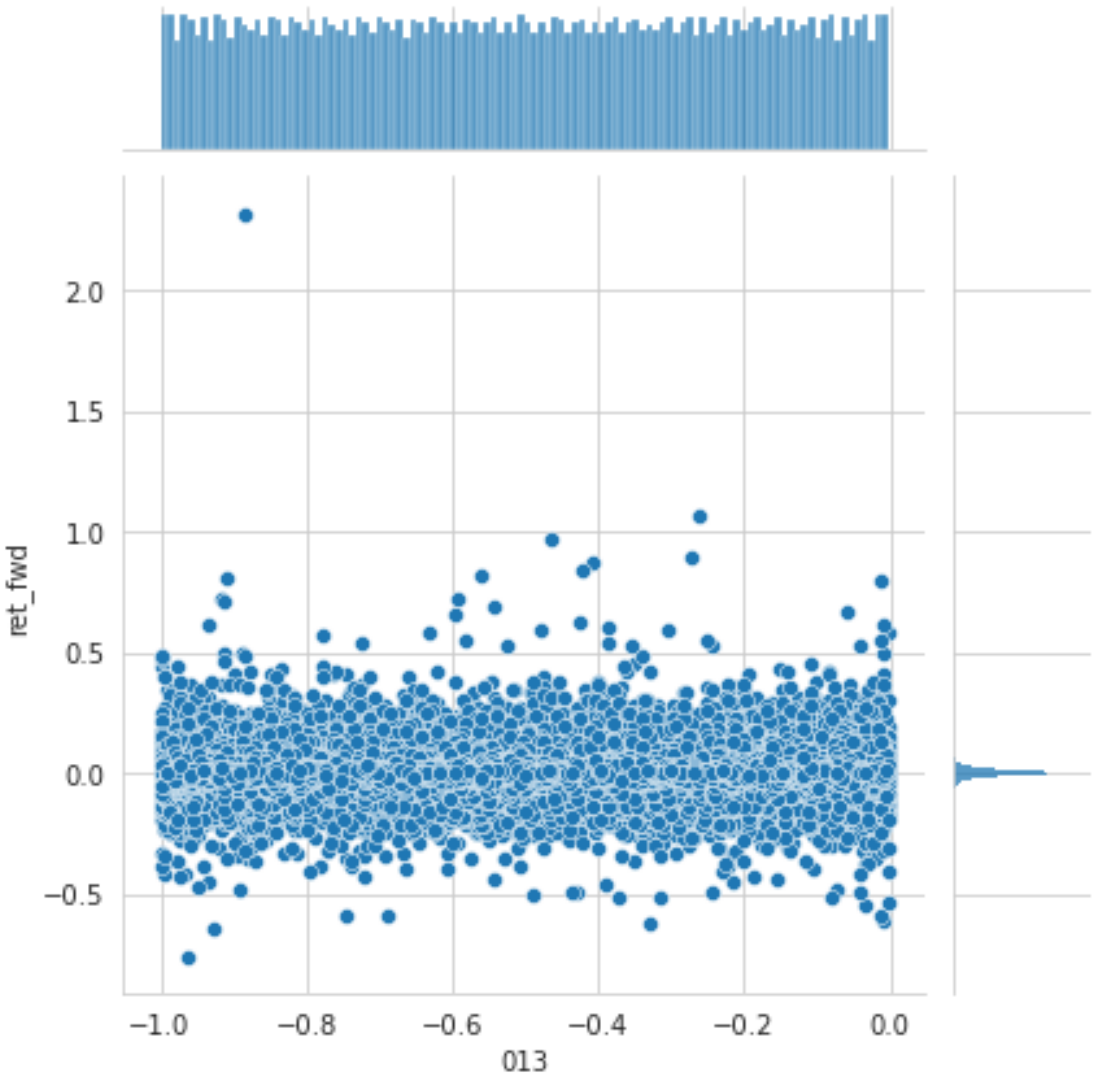
```
CPU times: user 3.64 s, sys: 48.1 ms, total: 3.69 s
Wall time: 3.64 s
```

[129]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[130]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[131]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[132]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[133]:
```
mi[alpha]
```

[133]: 0.0019222442390711691

[134]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.18 Alpha 014

```
(-rank(ts_delta(returns, 3))) * ts_corr(open, volume, 10))
```

[135]:
```
def alpha014(o, v, r):
    """
    (-rank(ts_delta(returns, 3))) * ts_corr(open, volume, 10))
    """

    alpha = -rank(ts_delta(r, 3)).mul(ts_corr(o, v, 10)
                                      .replace([-np.inf,
                                                np.inf],
                                               np.nan))
    return (alpha
            .stack('ticker')
            .swaplevel())
```

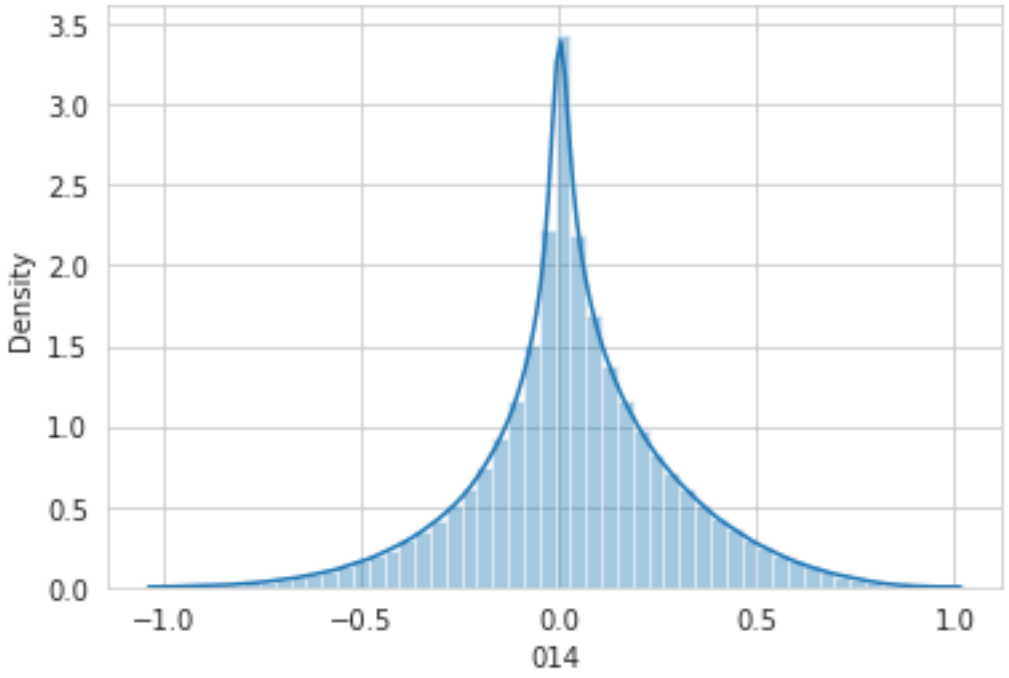
[136]:
```
alpha = 14
```

[137]:
```
%%time
alphas[f'{alpha:03}'] = alpha014(o, v, r)
```

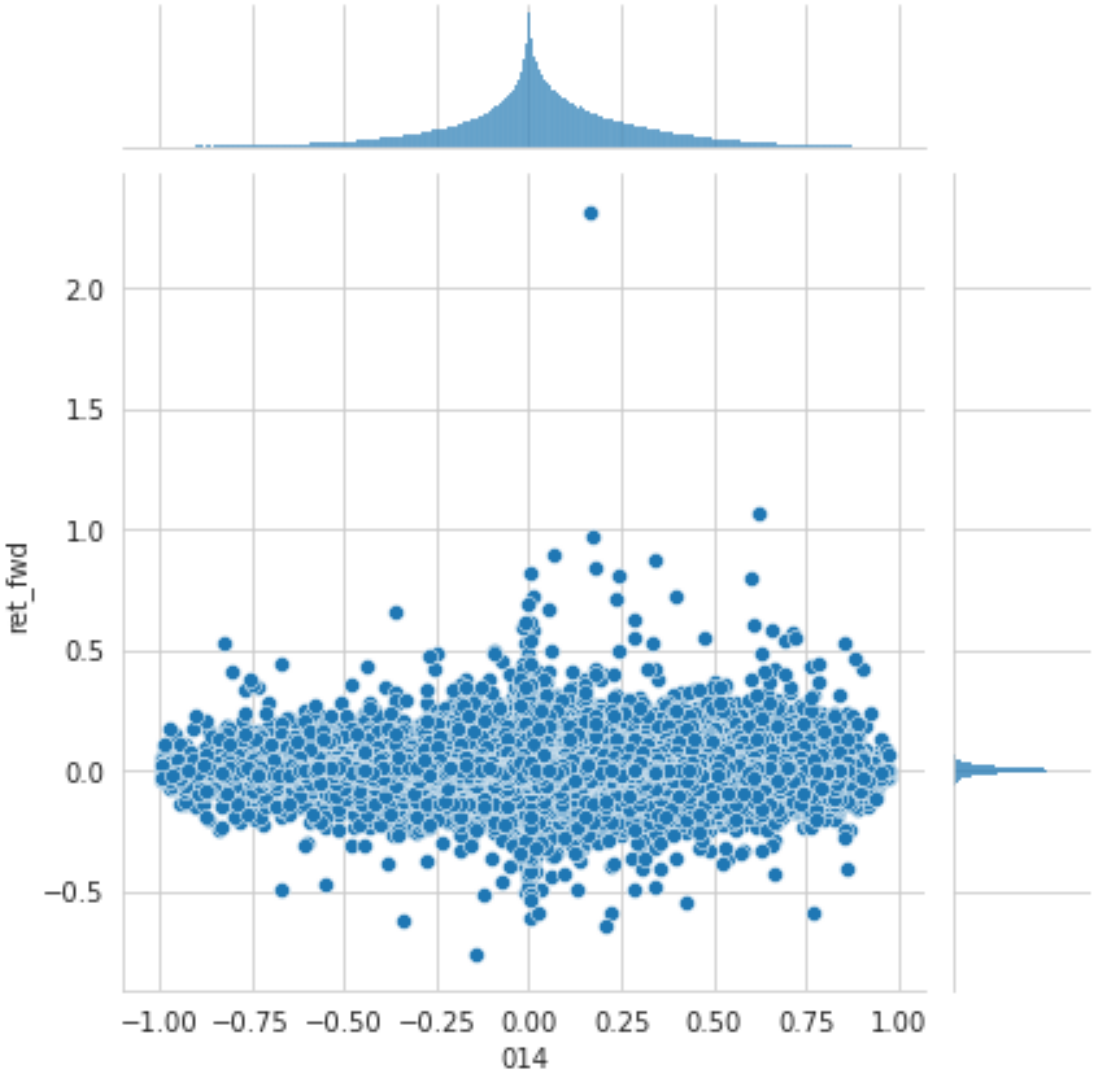
```
CPU times: user 3.58 s, sys: 36 ms, total: 3.62 s
Wall time: 3.58 s
```

[138]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[139]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[140]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[141]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[142]:
```
mi[alpha]
```

[142]:
```
0.0009324039861251521
```

1.19 Alpha 015

```
(-1 * ts_sum(rank(ts_corr(rank(high), rank(volume), 3)), 3))
```

[143]:
```
def alpha015(h, v):
    """(-1 * ts_sum(rank(ts_corr(rank(high), rank(volume), 3)), 3))"""
    alpha = (-ts_sum(rank(ts_corr(rank(h), rank(v), 3)
                          .replace([-np.inf, np.inf], np.nan)), 3))
    return (alpha
            .stack('ticker')
            .swaplevel())
```

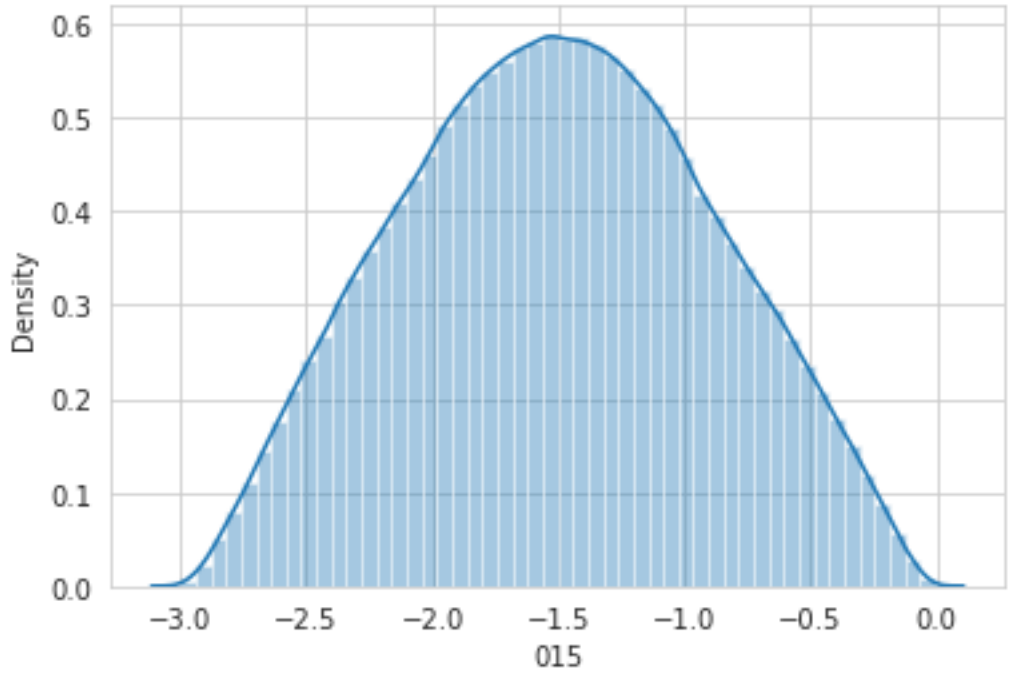
[144]:
```
alpha = 15
```

[145]:
```
%%time
alphas[f'{alpha:03}'] = alpha015(h, v)
```

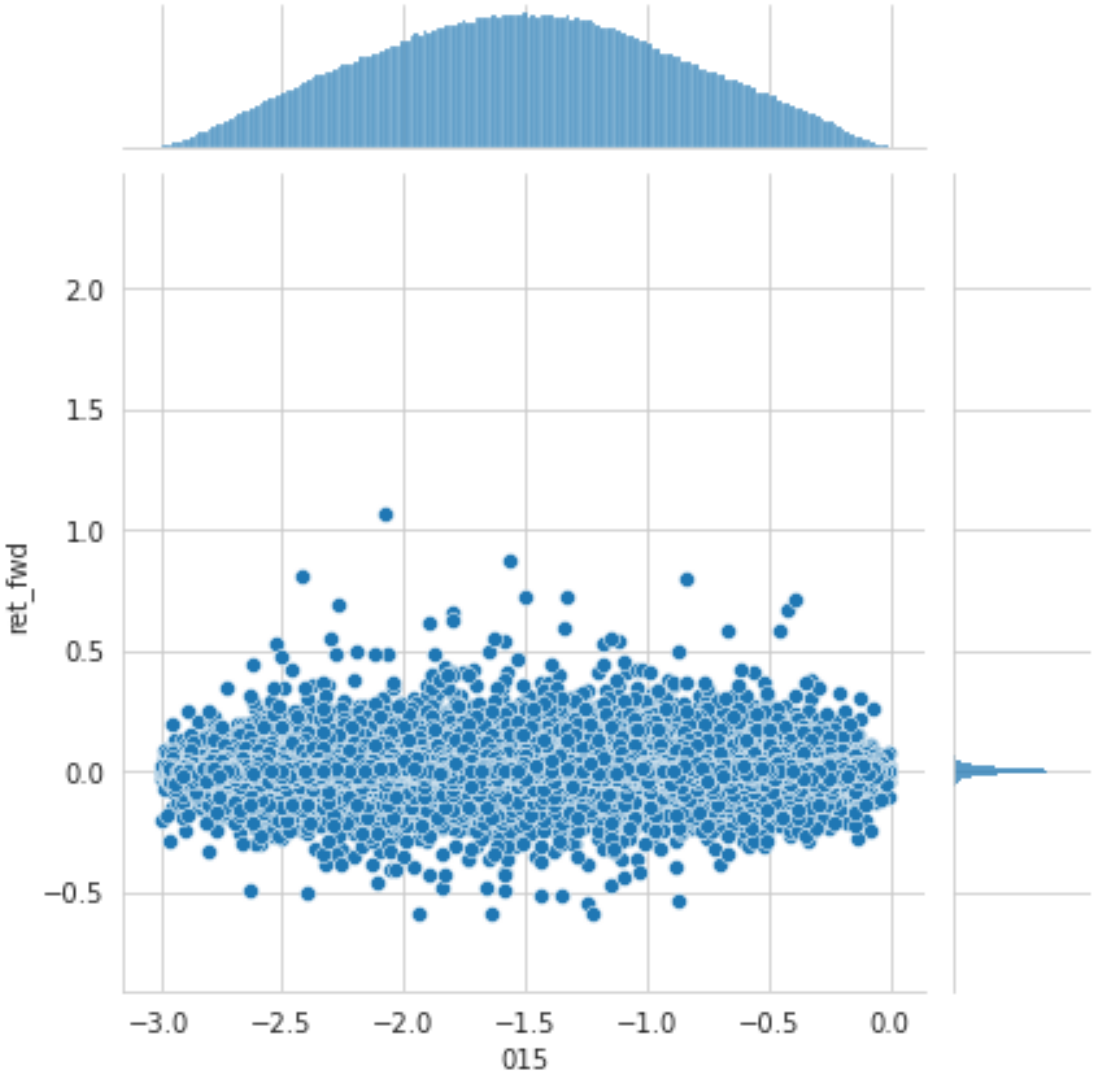
```
CPU times: user 3.44 s, sys: 24.1 ms, total: 3.47 s
Wall time: 3.44 s
```

[146]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[147]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[148]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[149]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[150]:
```
mi[alpha]
```

[150]: 0.0011393971145832182

1.20 Alpha 016

(-1 * rank(ts_cov(rank(high), rank(volume), 5)))

[151]:
```
def alpha016(h, v):
    """(-1 * rank(ts_cov(rank(high), rank(volume), 5)))"""
    return (-rank(ts_cov(rank(h), rank(v), 5))
            .stack('ticker')
```

```
            .swaplevel())
```

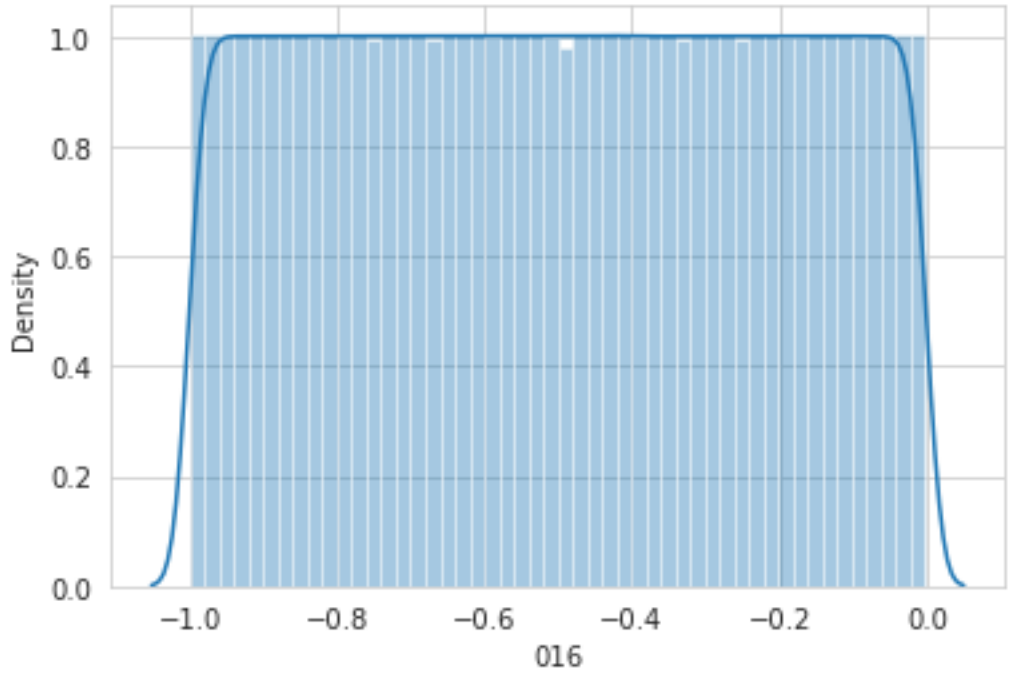
[152]:
```
alpha = 16
```

[153]:
```
%%time
alphas[f'{alpha:03}'] = alpha016(h, v)
```

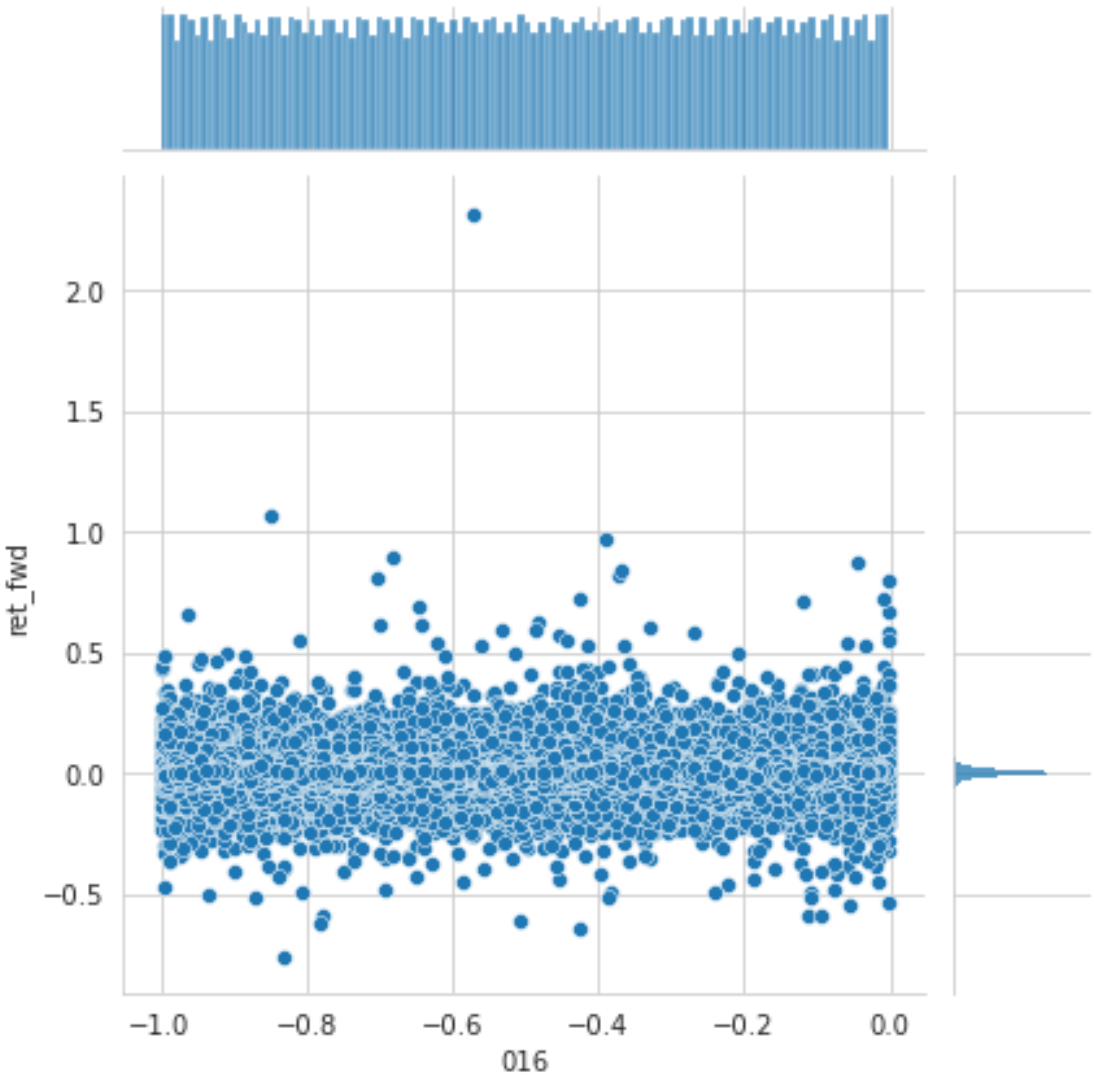
```
CPU times: user 2.89 s, sys: 44.1 ms, total: 2.94 s
Wall time: 2.91 s
```

[154]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[155]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[156]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[157]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[158]:
```
mi[alpha]
```

[158]: 0

[159]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.21 Alpha 017

```
rank(((0 < ts_min(ts_delta(close, 1), 4))
? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 4) < 0)
    ? ts_delta(close, 1)
```

```
    : (-1 * ts_delta(close, 1)))))
```

[160]:
```
def alpha017(c, v):
    """(((-1 * rank(ts_rank(close, 10))) * rank(ts_delta(ts_delta(close, 1),␣
↪1))) *rank(ts_rank((volume / adv20), 5)))
        """
    adv20 = ts_mean(v, 20)
    return (-rank(ts_rank(c, 10))
            .mul(rank(ts_delta(ts_delta(c, 1), 1)))
            .mul(rank(ts_rank(v.div(adv20), 5)))
            .stack('ticker')
            .swaplevel())
```

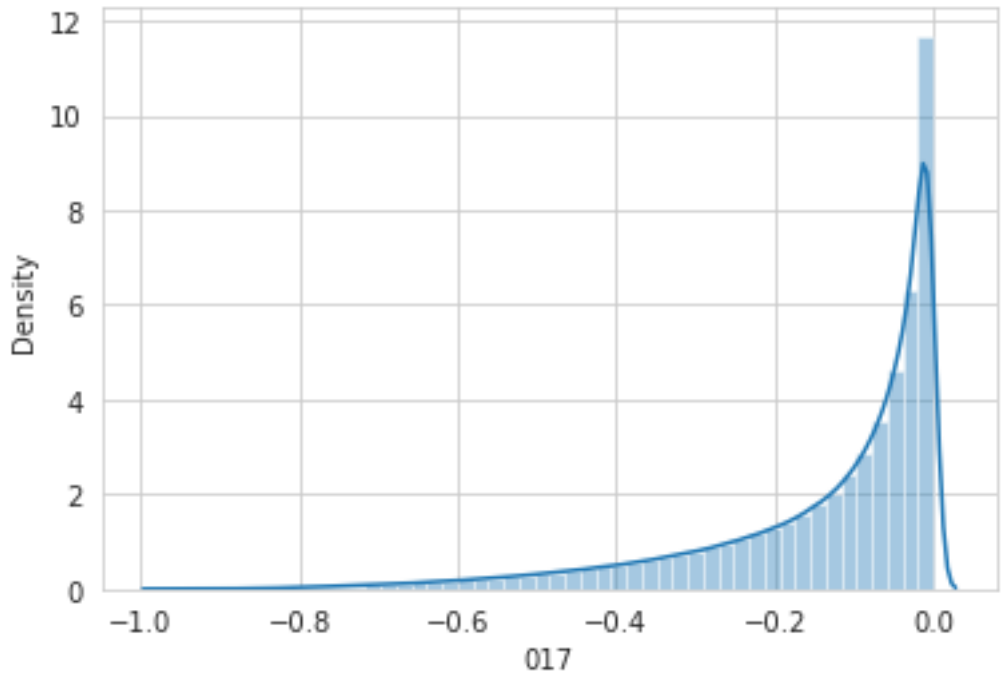
[161]:
```
alpha = 17
```

[162]:
```
%%time
alphas[f'{alpha:03}'] = alpha017(c, v)
```

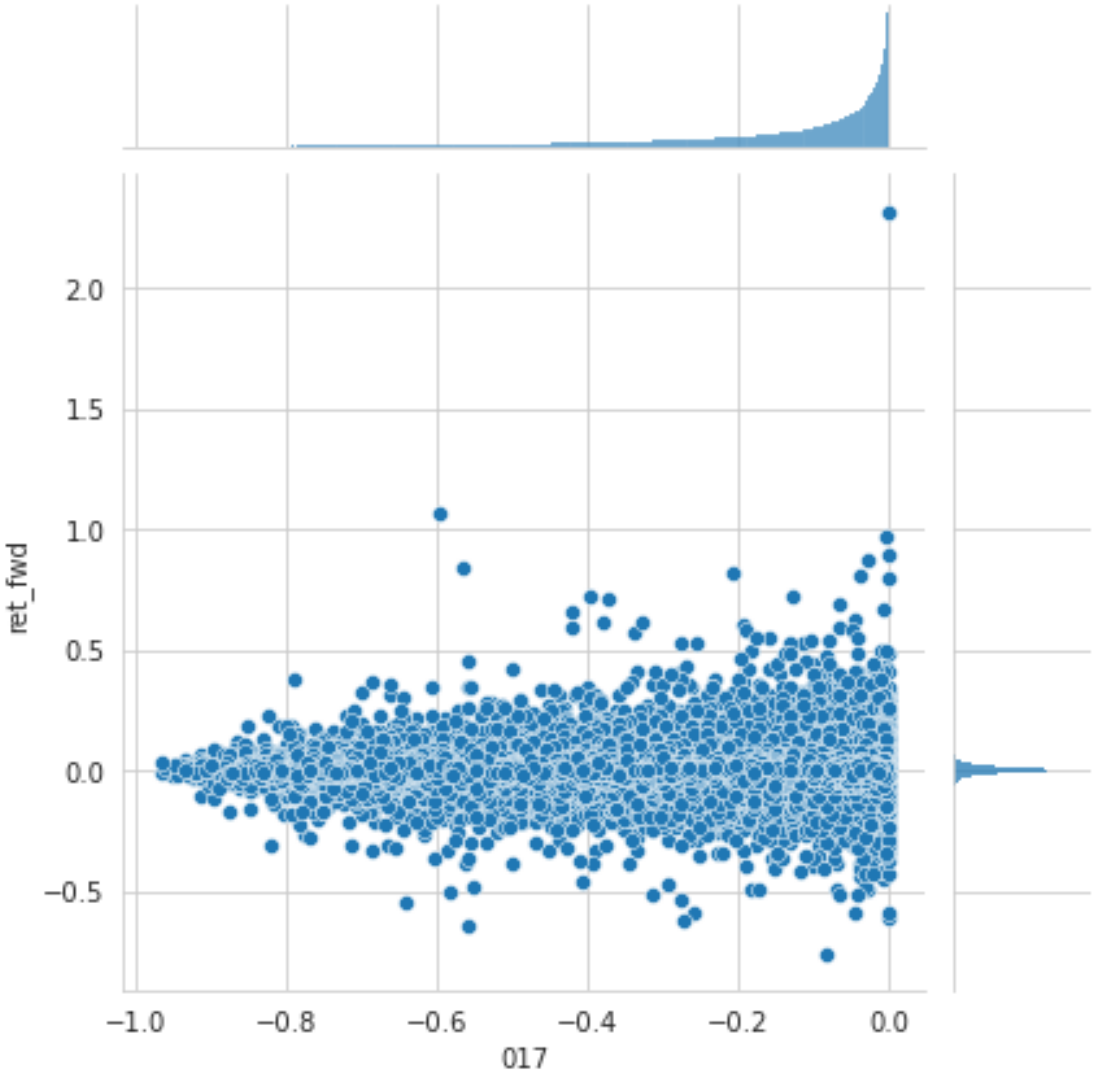
```
CPU times: user 5min 59s, sys: 127 ms, total: 5min 59s
Wall time: 5min 59s
```

[163]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[164]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[165]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[166]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[167]:
```
mi[alpha]
```

[167]: 0

1.22 Alpha 018

```
-rank((ts_std(abs((close - open)), 5) + (close - open)) +
           ts_corr(close, open,10))
```

[168]:
```
def alpha018(o, c):
    """-rank((ts_std(abs((close - open)), 5) + (close - open)) +
            ts_corr(close, open,10))
    """
    return (-rank(ts_std(c.sub(o).abs(), 5)
                  .add(c.sub(o))
                  .add(ts_corr(c, o, 10)
                       .replace([-np.inf,
                                 np.inf],
                                np.nan)))
            .stack('ticker')
            .swaplevel())
```

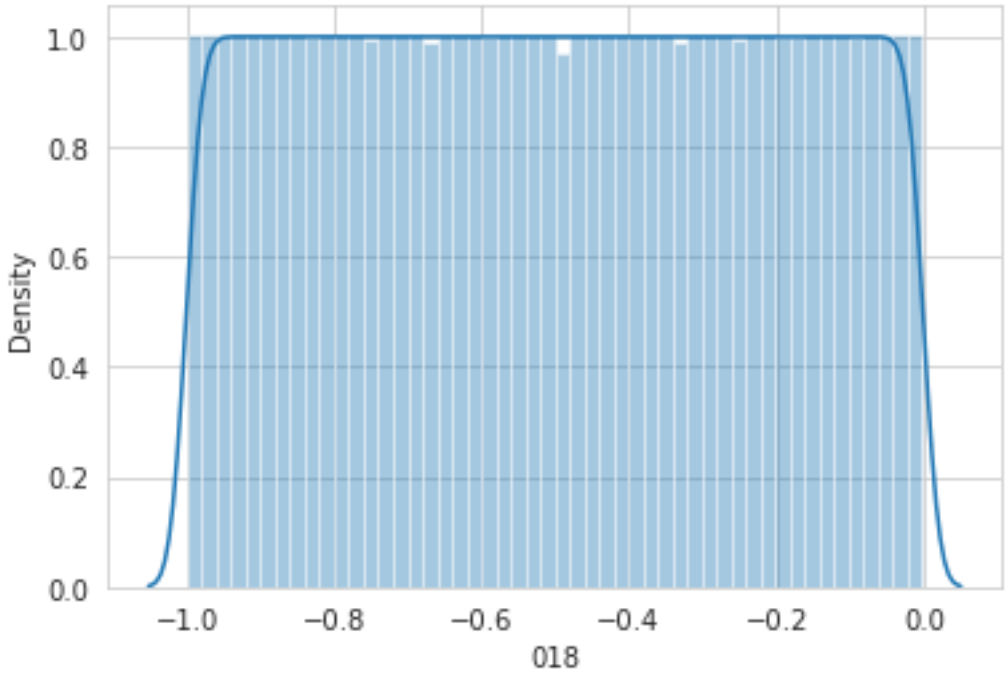
[169]:
```
alpha = 18
```

[170]:
```
%%time
alphas[f'{alpha:03}'] = alpha018(o, c)
```

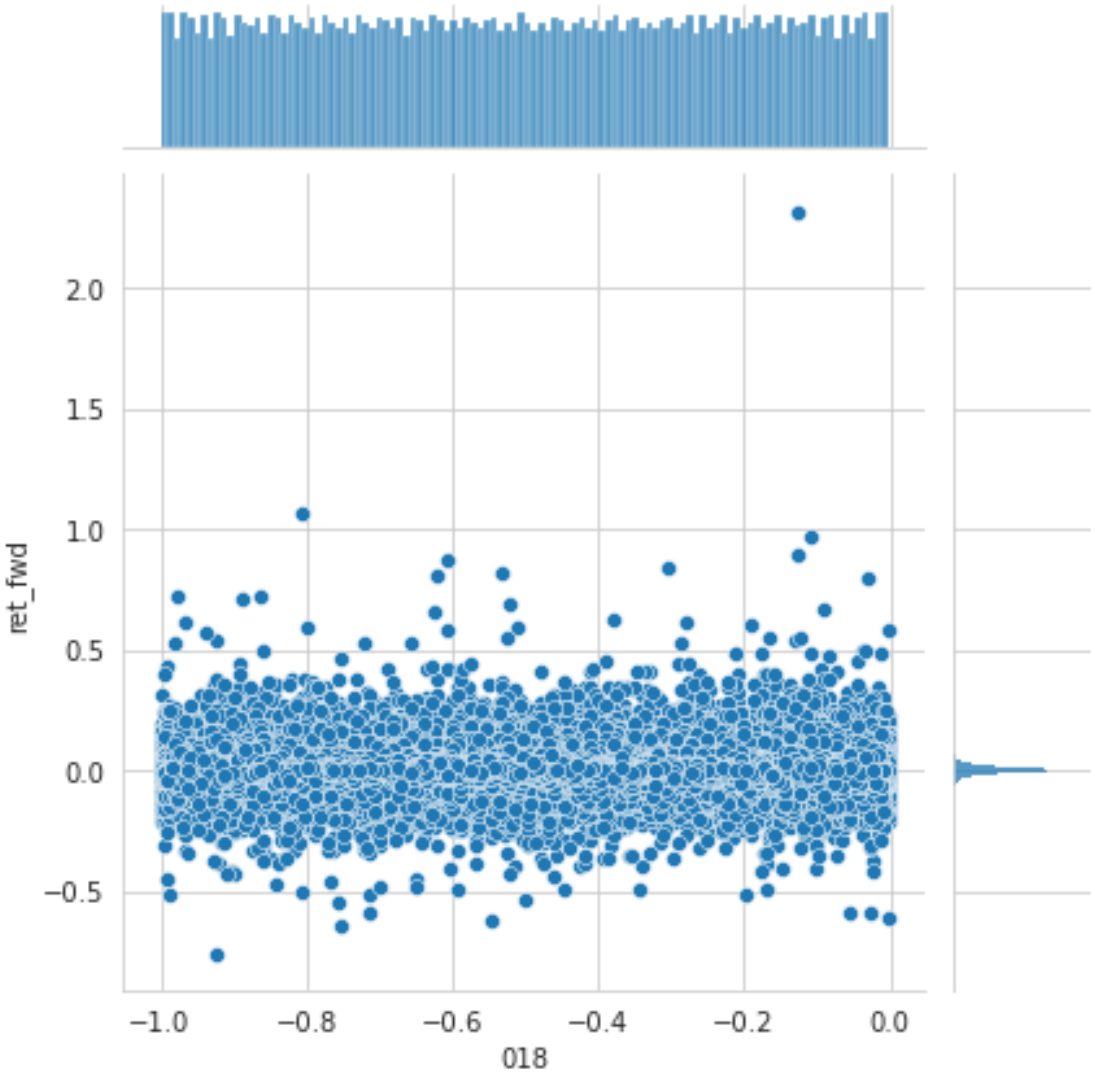
```
CPU times: user 3.64 s, sys: 84.1 ms, total: 3.72 s
Wall time: 3.64 s
```

[171]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[172]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[173]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[174]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[175]:
```
mi[alpha]
```

[175]: 0

1.23 Alpha 019

```
rank(((0 < ts_min(ts_delta(close, 1), 4))
? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 4) < 0)
    ? ts_delta(close, 1)
```

```
    : (-1 * ts_delta(close, 1)))))
```

[176]:
```
def alpha019(c, r):
    """((-1 * sign(((close - ts_lag(close, 7)) + ts_delta(close, 7)))) *
    (1 + rank((1 + ts_sum(returns,250)))))
    """
    return (-sign(ts_delta(c, 7) + ts_delta(c, 7))
            .mul(1 + rank(1 + ts_sum(r, 250)))
            .stack('ticker')
            .swaplevel())
```

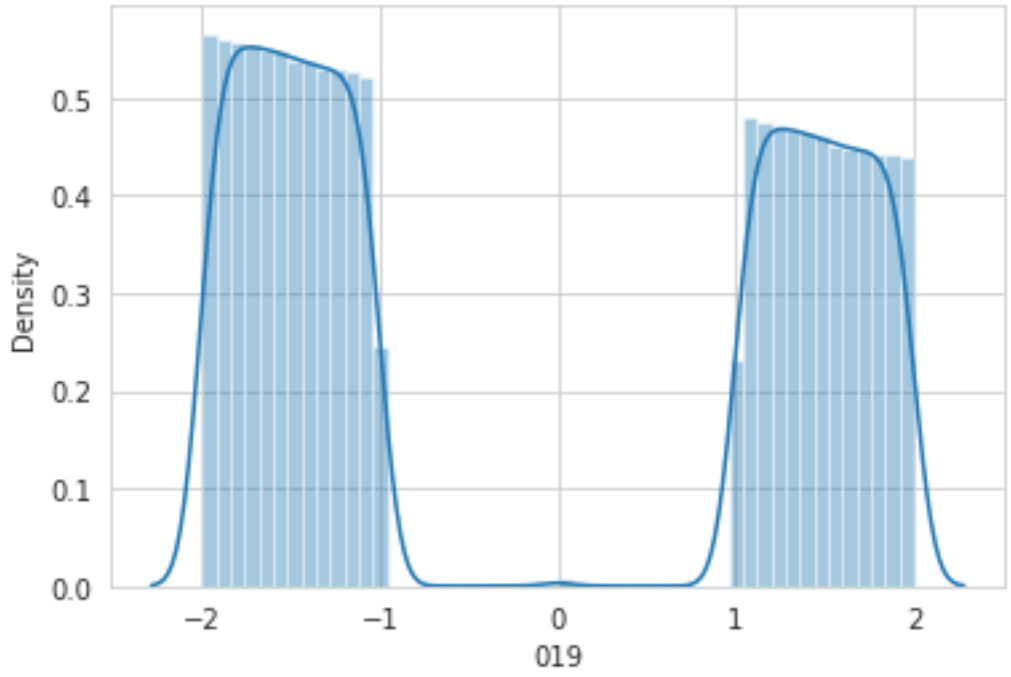
[177]:
```
alpha = 19
```

[178]:
```
%%time
alphas[f'{alpha:03}'] = alpha019(c, r)
```

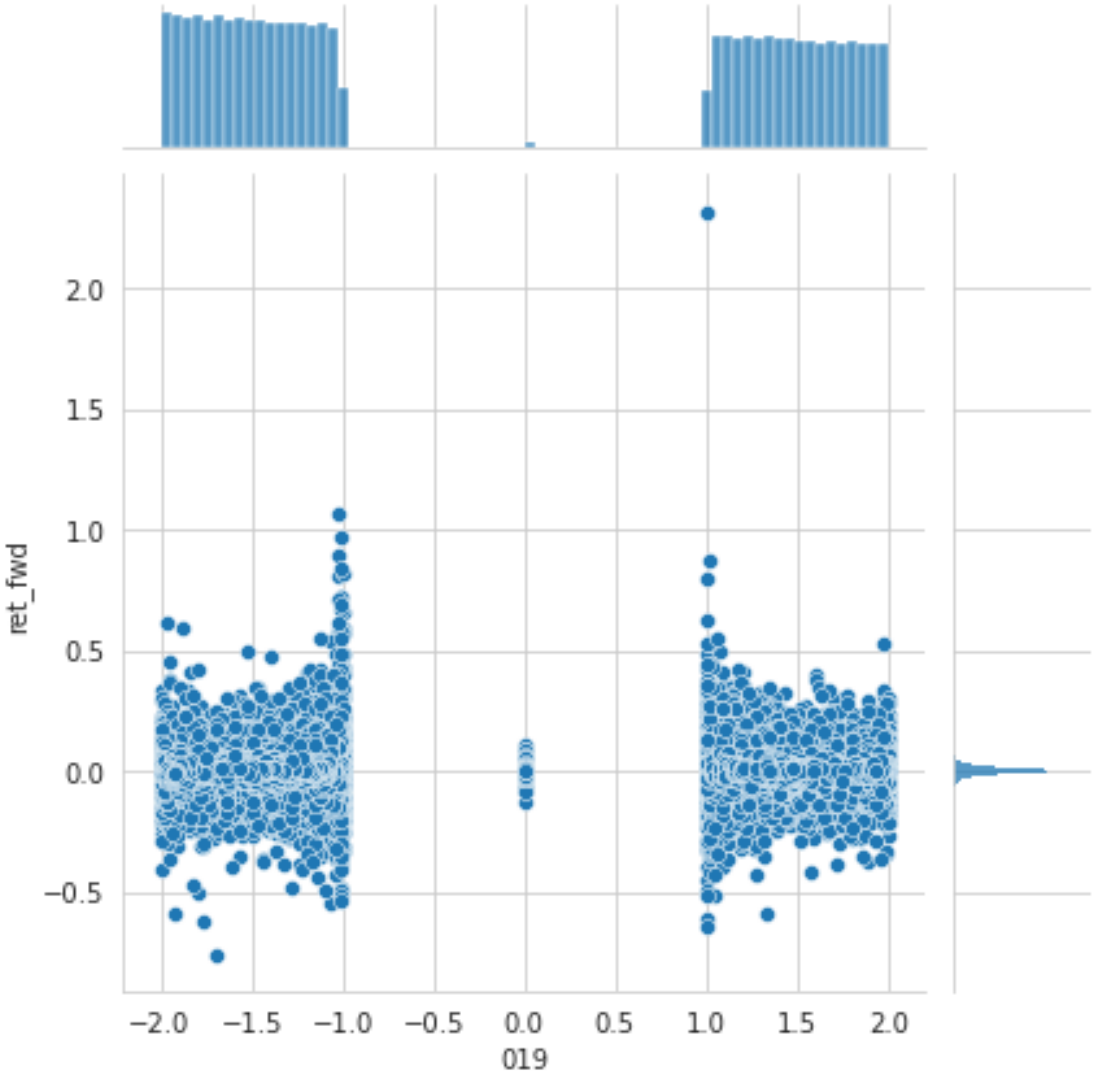
```
CPU times: user 2.33 s, sys: 24 ms, total: 2.36 s
Wall time: 2.33 s
```

[179]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[180]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[181]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[182]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[183]:
```
mi[alpha]
```

[183]: 0.010082898712334476

[184]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.24 Alpha 020

```
-rank(open - ts_lag(high, 1)) *
 rank(open - ts_lag(close, 1)) *
 rank(open -ts_lag(low, 1))
```

[185]:
```
def alpha020(o, h, l, c):
    """-rank(open - ts_lag(high, 1)) *
        rank(open - ts_lag(close, 1)) *
        rank(open -ts_lag(low, 1))"""
    return (rank(o - ts_lag(h, 1))
            .mul(rank(o - ts_lag(c, 1)))
            .mul(rank(o - ts_lag(l, 1)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

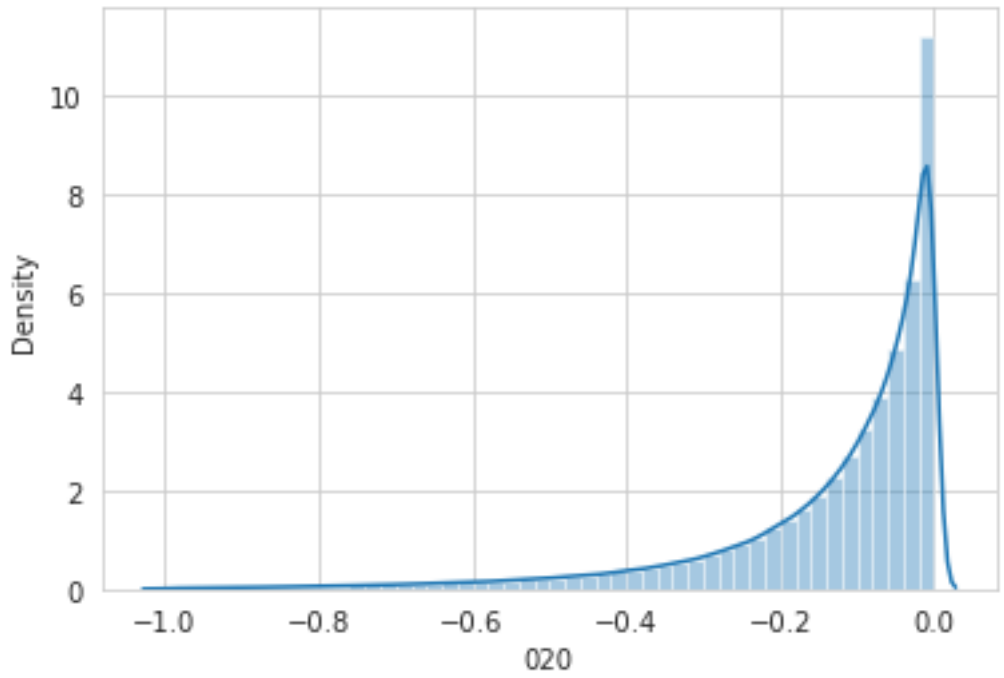
[186]:
```
alpha = 20
```

[187]:
```
%%time
alphas[f'{alpha:03}'] = alpha020(o, h, l, c)
```

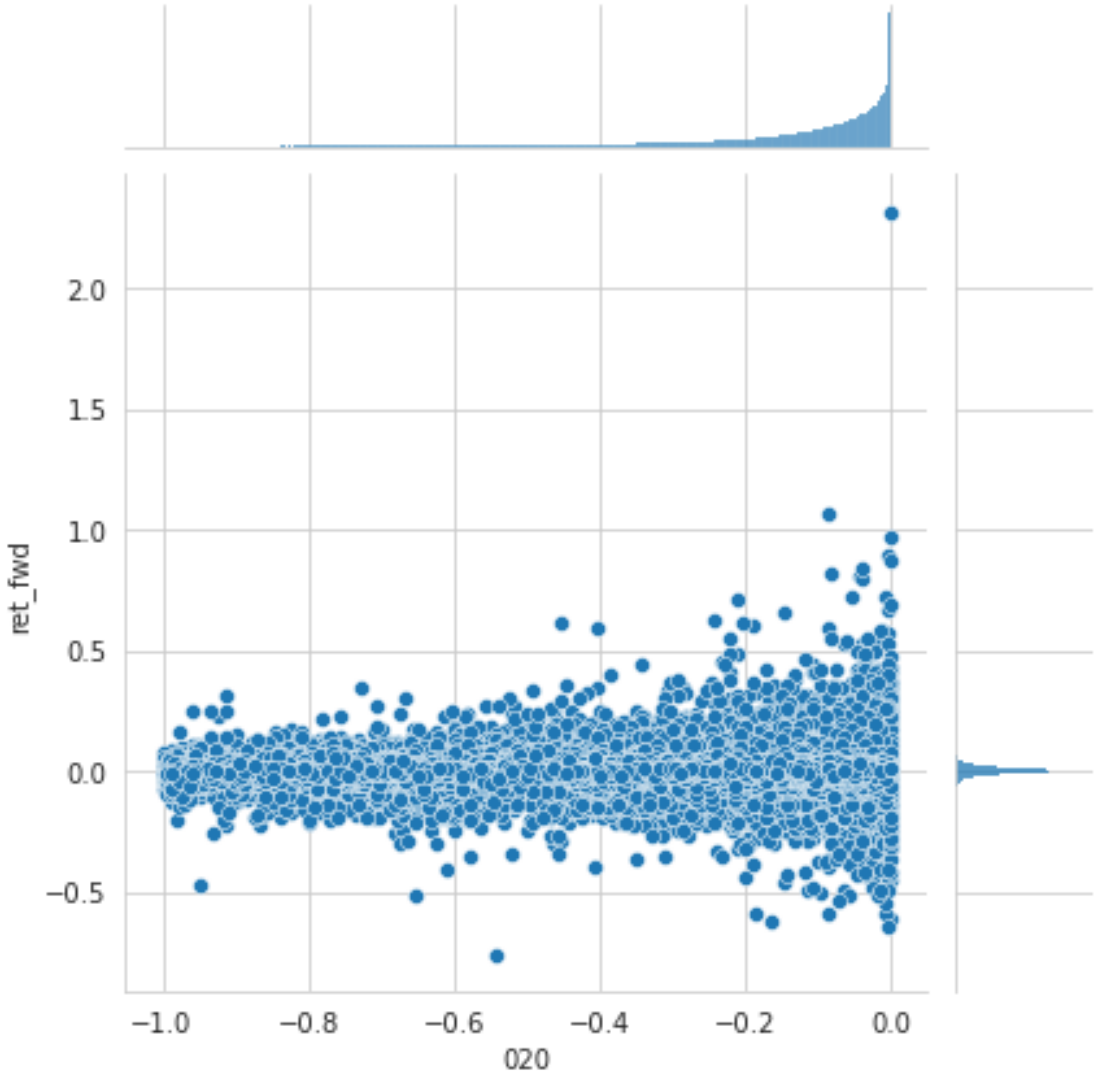
```
CPU times: user 2.4 s, sys: 64 ms, total: 2.47 s
Wall time: 2.4 s
```

[188]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[189]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[190]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[191]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[192]:
```
mi[alpha]
```

[192]: 0.002095780517723078

1.25 Alpha 021

```
ts_mean(close, 8) + ts_std(close, 8) < ts_mean(close, 2)
        ? -1
        : (ts_mean(close,2) < ts_mean(close, 8) - ts_std(close, 8)
            ? 1
            : (volume / adv20 < 1
                ? -1
```

```
                    : 1))
```

[193]:
```
def alpha021(c, v):
    """ts_mean(close, 8) + ts_std(close, 8) < ts_mean(close, 2)
        ? -1
        : (ts_mean(close,2) < ts_mean(close, 8) - ts_std(close, 8)
            ? 1
            : (volume / adv20 < 1
                ? -1
                : 1))
    """
    sma2 = ts_mean(c, 2)
    sma8 = ts_mean(c, 8)
    std8 = ts_std(c, 8)

    cond_1 = sma8.add(std8) < sma2
    cond_2 = sma8.add(std8) > sma2
    cond_3 = v.div(ts_mean(v, 20)) < 1

    val = np.ones_like(c)
    alpha = pd.DataFrame(np.select(condlist=[cond_1, cond_2, cond_3],
                                   choicelist=[-1, 1, -1], default=1),
                         index=c.index,
                         columns=c.columns)

    return (alpha
            .stack('ticker')
            .swaplevel())
```

[194]:
```
alpha = 21
```

[195]:
```
%%time
alphas[f'{alpha:03}'] = alpha021(c, v)
```

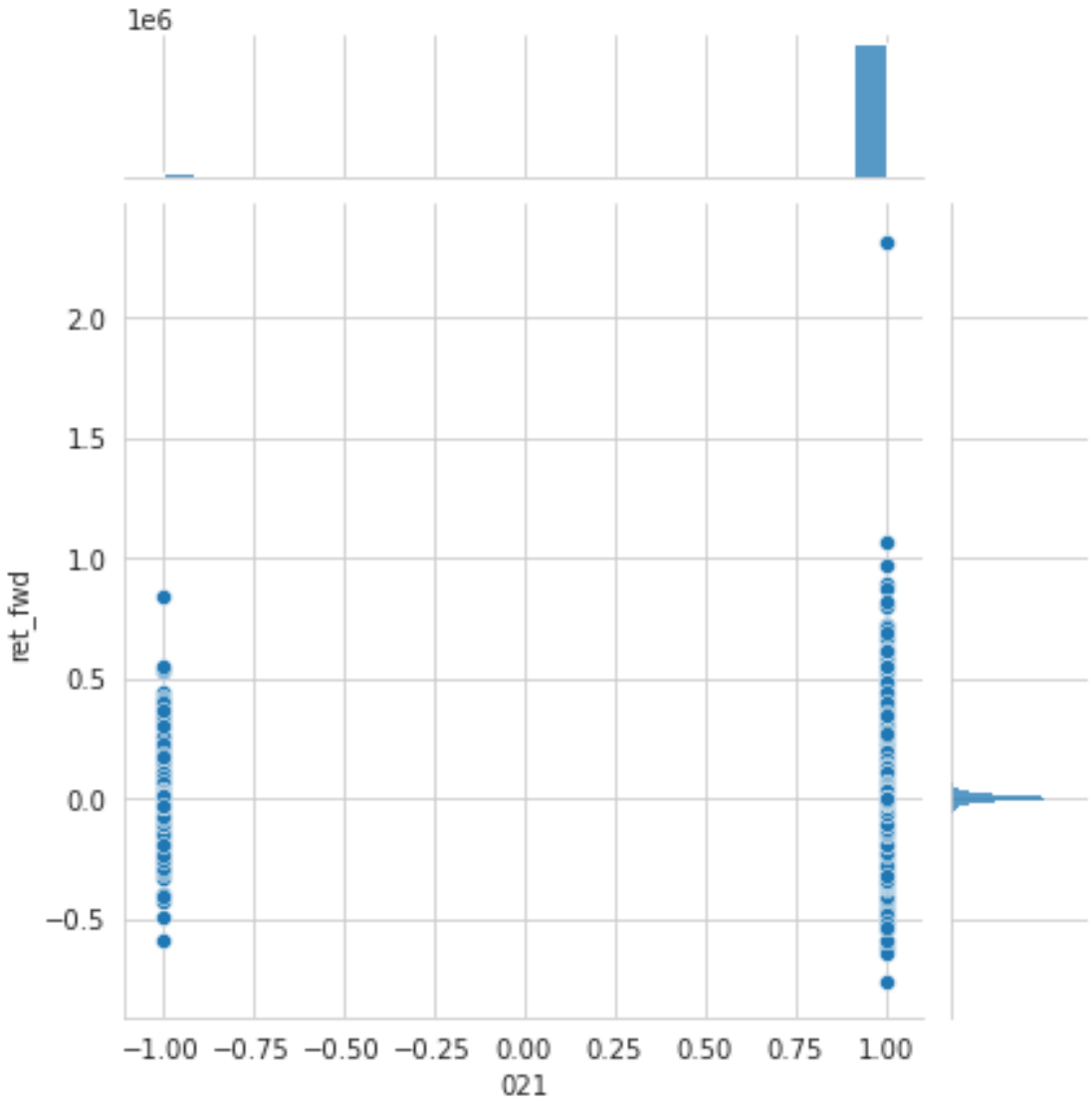
```
CPU times: user 2.15 s, sys: 16 ms, total: 2.17 s
Wall time: 2.13 s
```

[196]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[197]:
```
alphas[f'{alpha:03}'].value_counts()
```

[197]:
```
 1    1211187
-1      43906
Name: 021, dtype: int64
```

[198]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[199]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[200]:
```
# mi[alpha]
```

1.26 Alpha 022

```
-(ts_delta(ts_corr(high, volume, 5), 5) *
       rank(ts_std(close, 20)))
```

[201]:
```
def alpha022(h, c, v):
    """-(ts_delta(ts_corr(high, volume, 5), 5) *
        rank(ts_std(close, 20)))
    """
```

```
    return (ts_delta(ts_corr(h, v, 5)
                     .replace([-np.inf,
                               np.inf],
                              np.nan), 5)
            .mul(rank(ts_std(c, 20)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

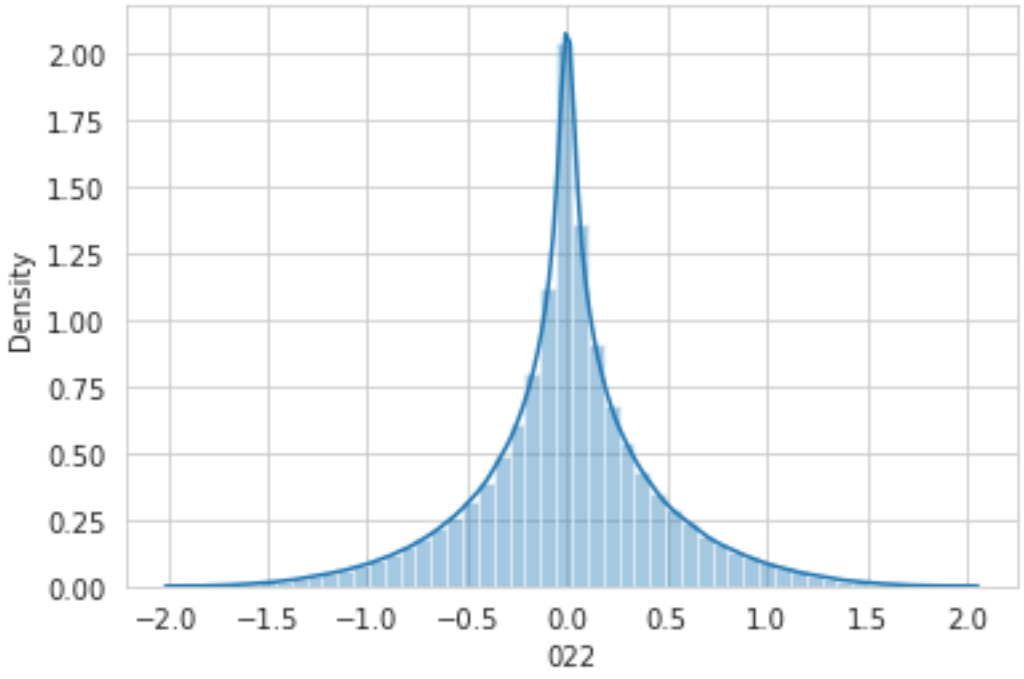
[202]:
```
alpha = 22
```

[203]:
```
%%time
alphas[f'{alpha:03}'] = alpha022(h, c, v)
```

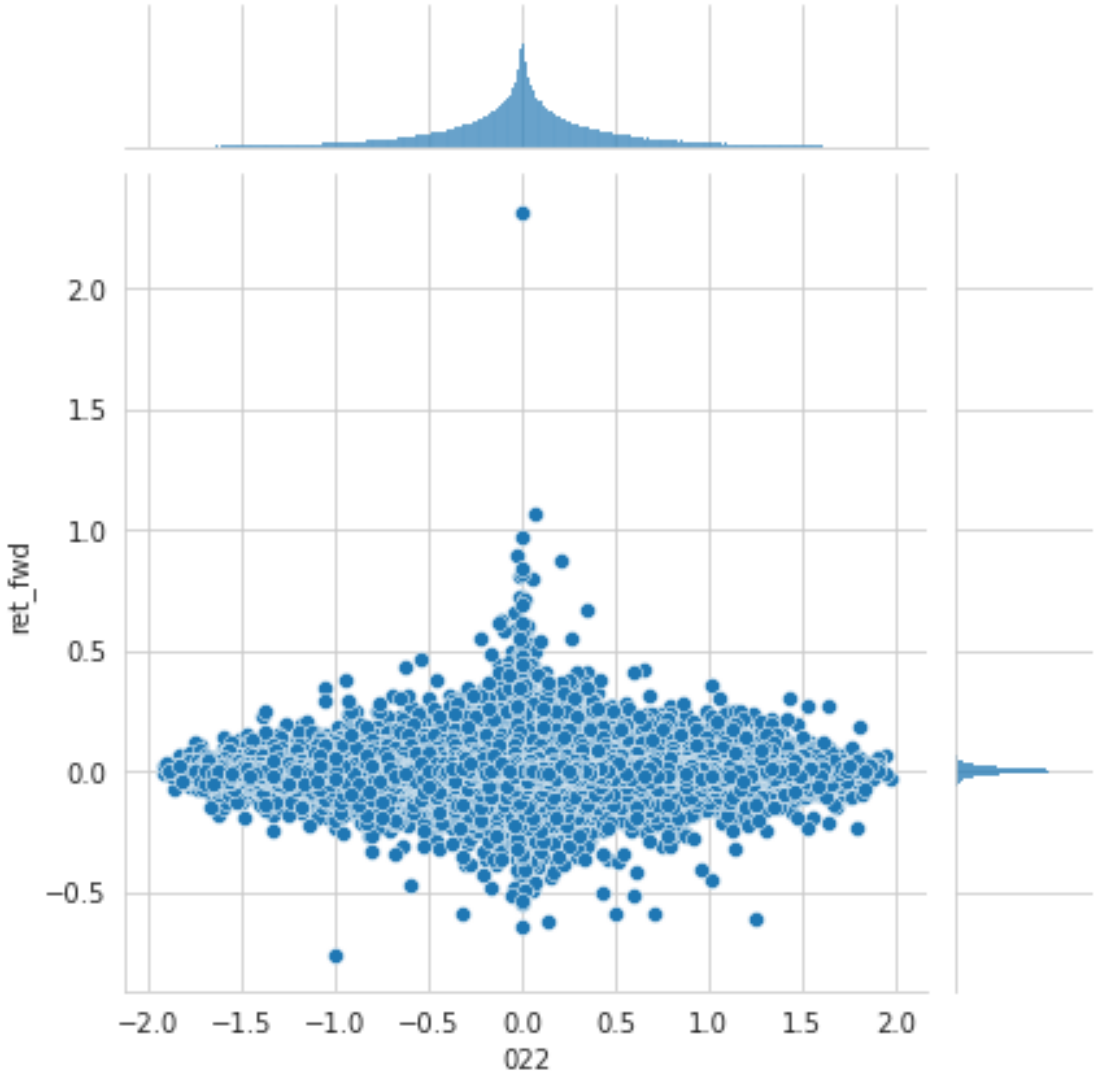
```
CPU times: user 3.47 s, sys: 52.1 ms, total: 3.52 s
Wall time: 3.45 s
```

[204]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[205]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[206]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[207]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[208]:
```
mi[alpha]
```

[208]: 0.0025639008286280074

[209]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.27 Alpha 023

```
((ts_sum(high, 20) / 20) < high)
           ? (-1 * ts_delta(high, 2))
           : 0
```

[210]:
```
def alpha023(h, c):
    """((ts_mean(high, 20) < high)
            ? (-1 * ts_delta(high, 2))
            : 0
        """

    return (ts_delta(h, 2)
            .mul(-1)
            .where(ts_mean(h, 20) < h, 0)
            .stack('ticker')
            .swaplevel())
```

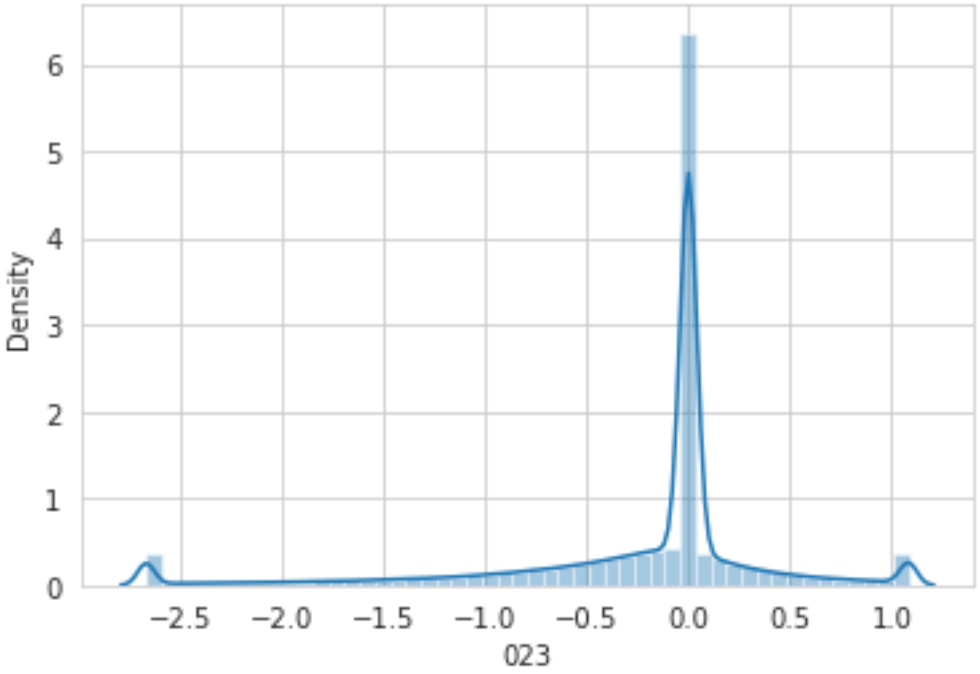
[211]:
```
alpha = 23
```

[212]:
```
%%time
alphas[f'{alpha:03}'] = alpha023(h, c)
```

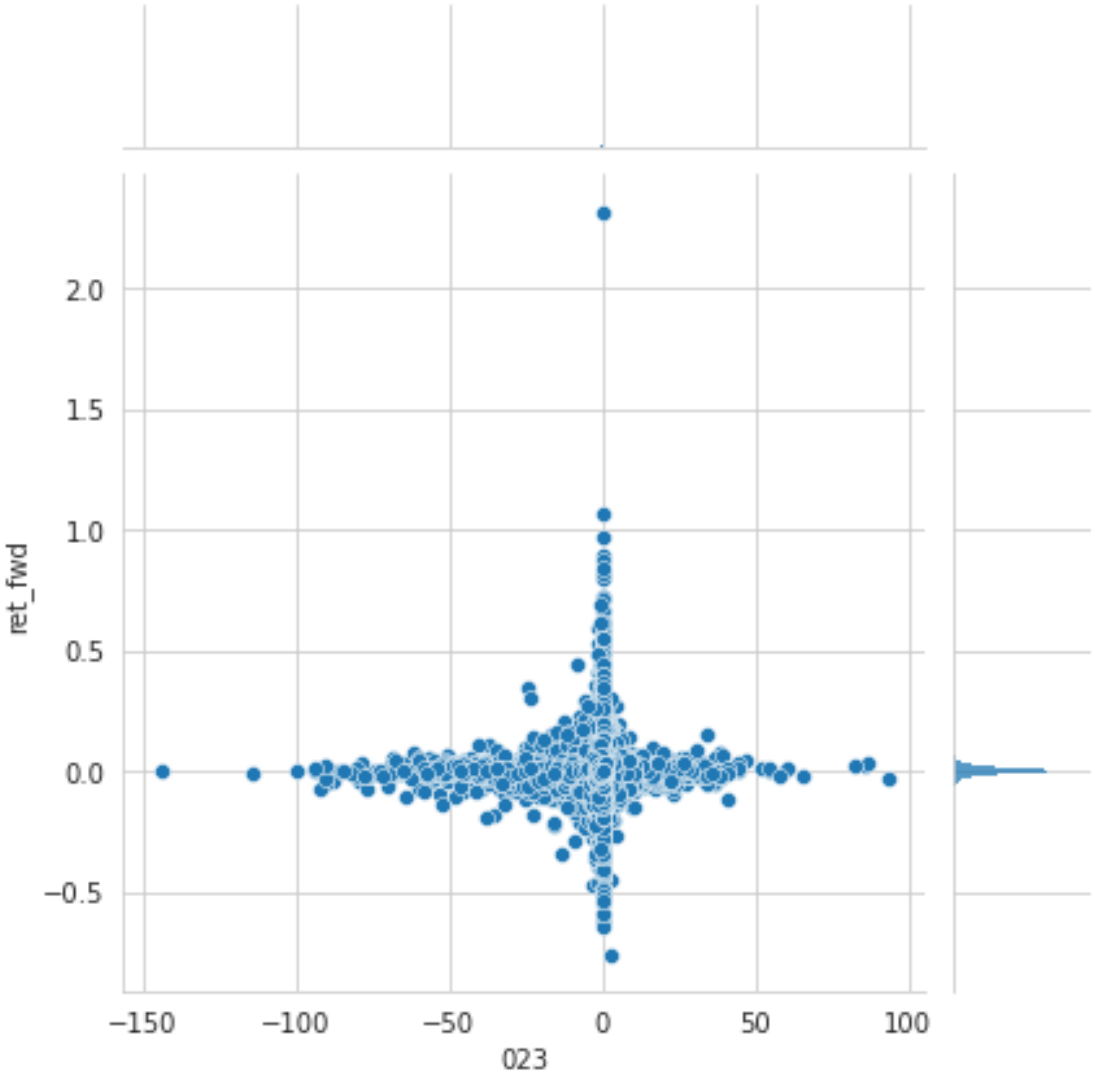
```
CPU times: user 2.49 s, sys: 8.05 ms, total: 2.5 s
Wall time: 2.48 s
```

[213]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[214]:
```
q = 0.025
sns.distplot(alphas[f'{alpha:03}'].clip(lower=alphas[f'{alpha:03}'].quantile(q),
                                        upper=alphas[f'{alpha:03}'].
 ↪quantile(1-q)));
```



[215]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[216]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[217]:
```
mi[alpha]
```

[217]: 0.010802888976805036

1.28 Alpha 024

```
((((ts_delta((ts_mean(close, 100)), 100) / ts_lag(close, 100)) <= 0.05)
        ? (-1 * (close - ts_min(close, 100)))
```

```
        : (-1 * ts_delta(close, 3)))
```

[218]:
```
def alpha024(c):
    """((((ts_delta((ts_mean(close, 100)), 100) / ts_lag(close, 100)) <= 0.05)
        ? (-1 * (close - ts_min(close, 100)))
        : (-1 * ts_delta(close, 3)))
    """
    cond = ts_delta(ts_mean(c, 100), 100) / ts_lag(c, 100) <= 0.05

    return (c.sub(ts_min(c, 100)).mul(-1).where(cond, -ts_delta(c, 3))
            .stack('ticker')
            .swaplevel())
```

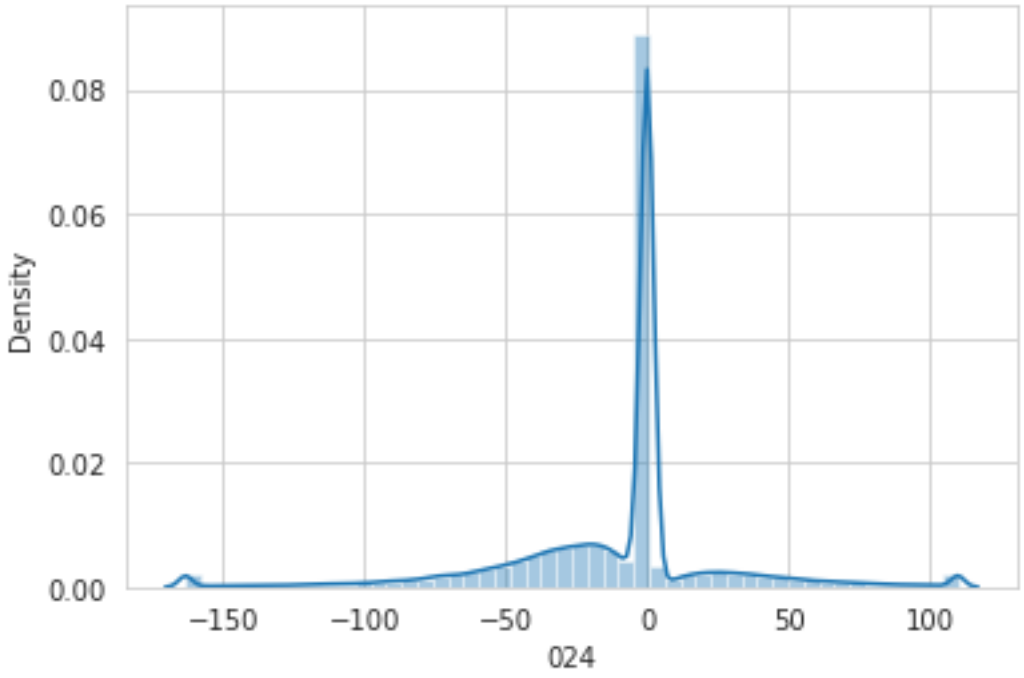
[219]:
```
alpha = 24
```

[220]:
```
%%time
alphas[f'{alpha:03}'] = alpha024(c)
```

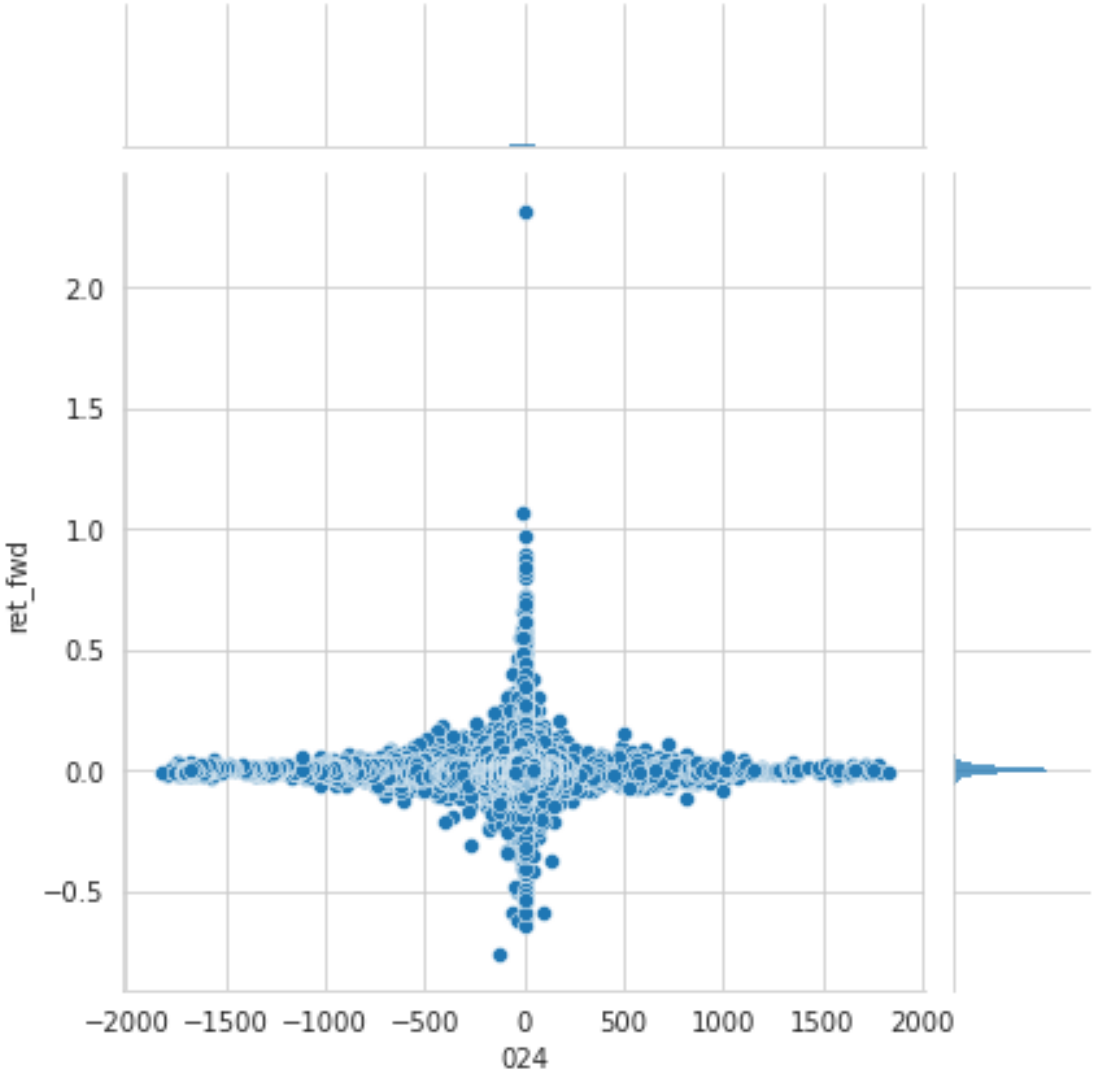
```
CPU times: user 2.45 s, sys: 48 ms, total: 2.5 s
Wall time: 2.44 s
```

[221]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[222]:
```
q = 0.01
sns.distplot(alphas[f'{alpha:03}'].clip(lower=alphas[f'{alpha:03}'].quantile(q),
                                        upper=alphas[f'{alpha:03}'].
 ↪quantile(1-q)));
```



[223]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[224]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[225]:
```
mi[alpha]
```

[225]:
```
0.031433111296676586
```

1.29 Alpha 025

```
rank((-1 * returns) * adv20 * vwap * (high - close))
```

[226]:
```
def alpha025(h, c, r, vwap, adv20):
    """rank((-1 * returns) * adv20 * vwap * (high - close))"""
    return (rank(-r.mul(adv20)
                 .mul(vwap)
                 .mul(h.sub(c)))
            .stack('ticker')
            .swaplevel())
```

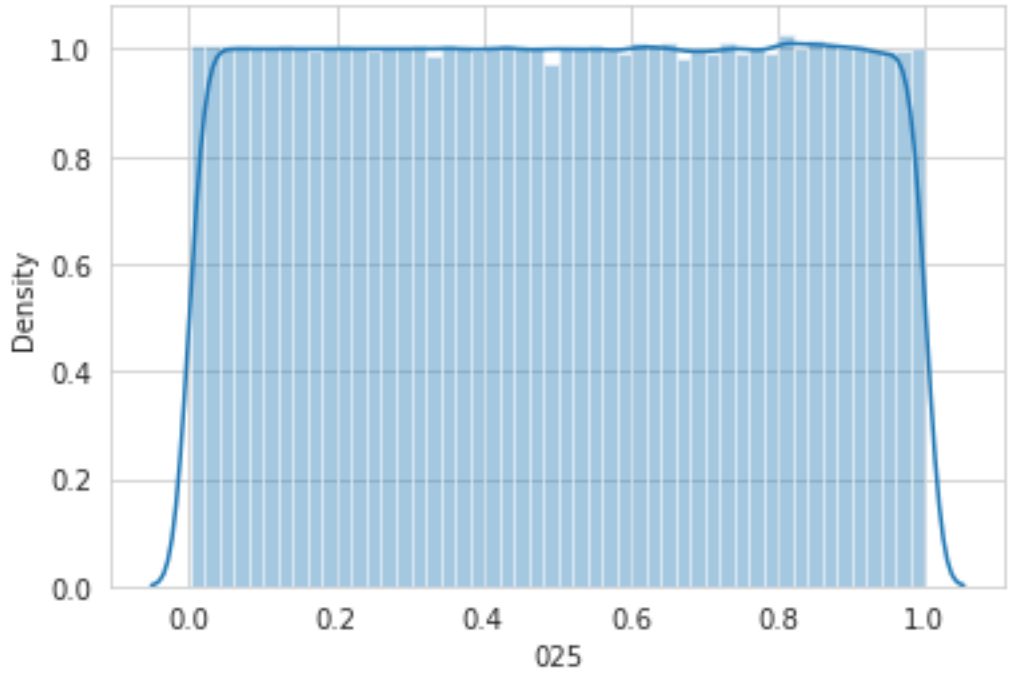
[227]:
```
alpha = 25
```

[228]:
```
%%time
alphas[f'{alpha:03}'] = alpha025(h, c, r, vwap, adv20)
```

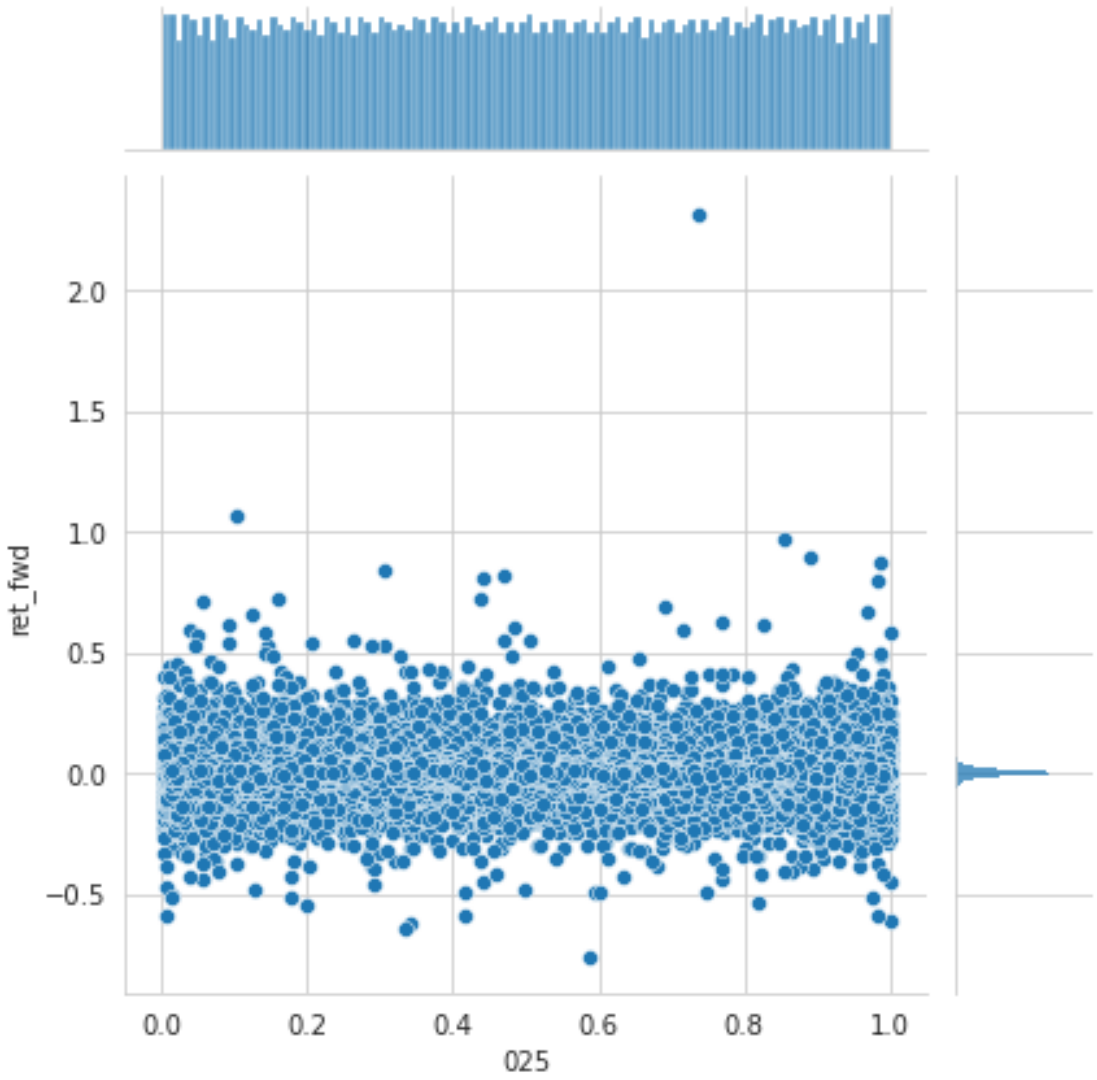
```
CPU times: user 2.9 s, sys: 36 ms, total: 2.93 s
Wall time: 2.9 s
```

[229]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[230]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[231]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[232]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[233]:
```
mi[alpha]
```

[233]: 0.002047811727091897

[234]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.30 Alpha 026

```
(-1 * rank(ts_cov(rank(high), rank(volume), 5)))
```

[235]:
```
def alpha026(h, v):
    """(-1 * ts_max(ts_corr(ts_rank(volume, 5), ts_rank(high, 5), 5), 3))"""
    return (ts_max(ts_corr(ts_rank(v, 5),
                           ts_rank(h, 5), 5)
                   .replace([-np.inf, np.inf], np.nan), 3)
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

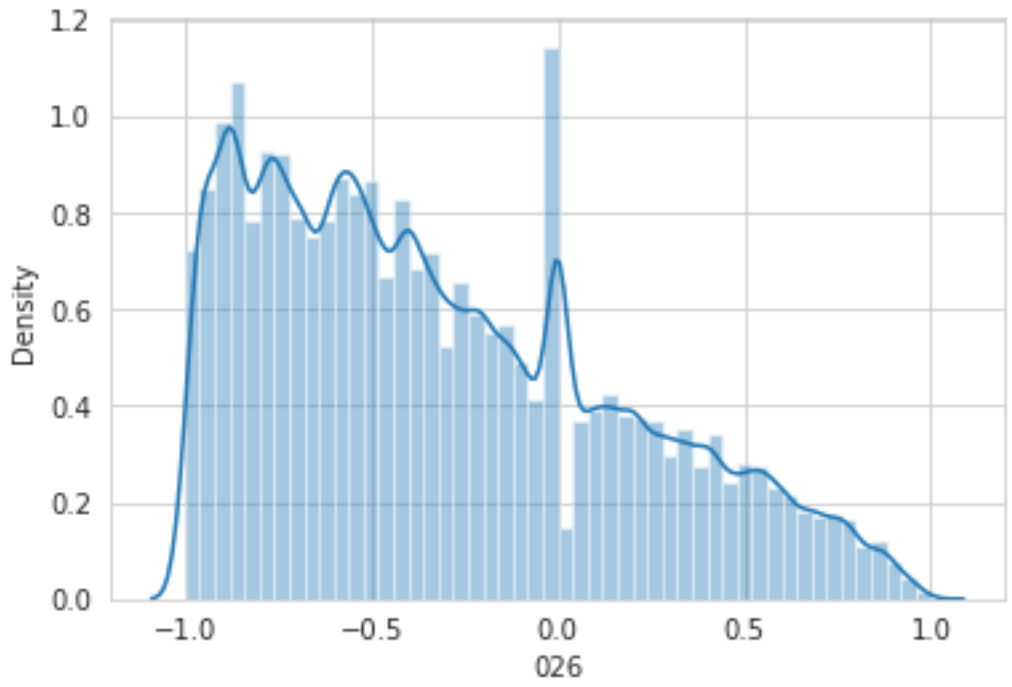
[236]:
```
alpha = 26
```

[237]:
```
%%time
alphas[f'{alpha:03}'] = alpha026(h, v)
```

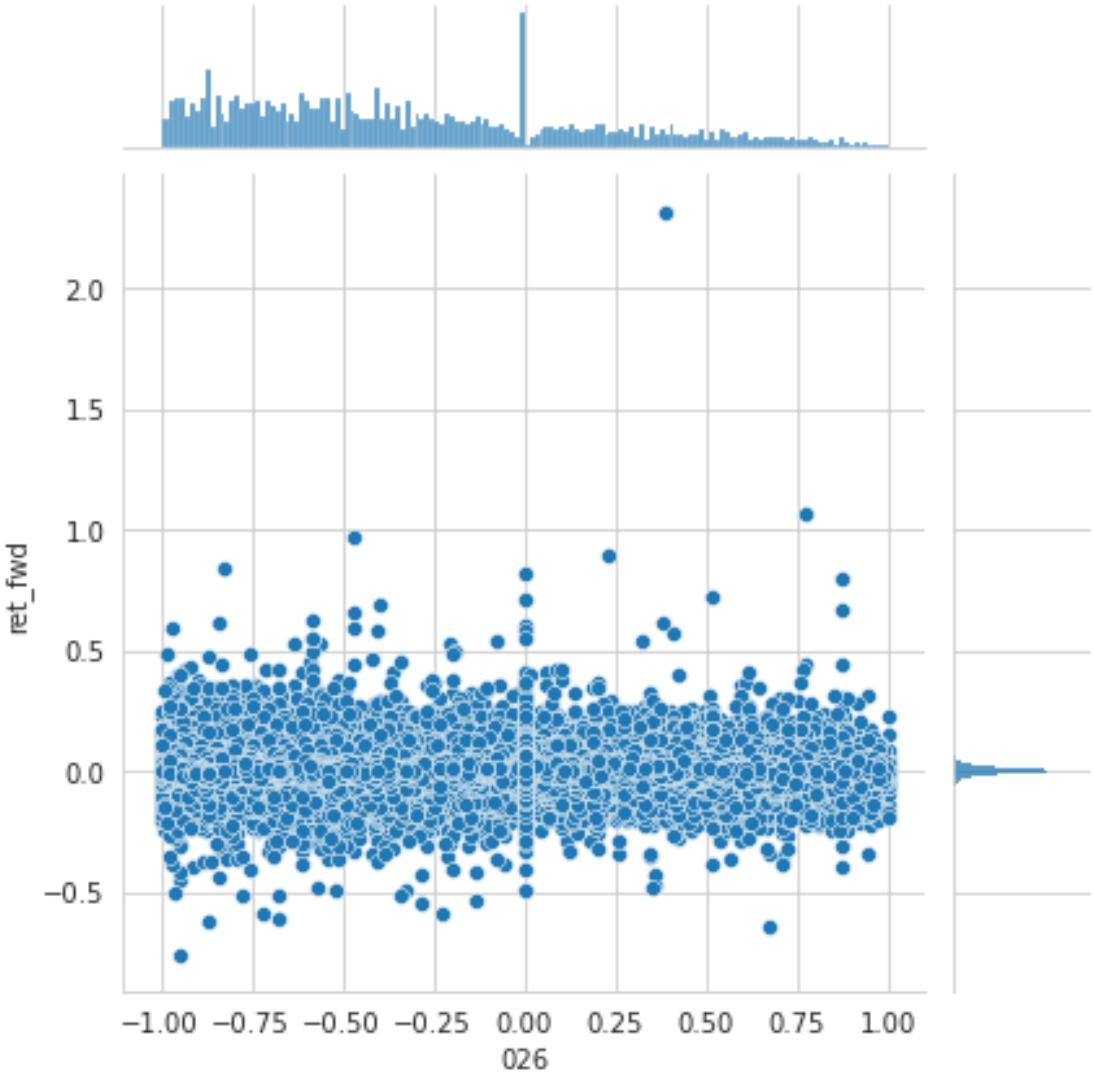
```
CPU times: user 6min 3s, sys: 148 ms, total: 6min 3s
Wall time: 6min 3s
```

[238]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[239]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[240]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[241]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[242]:
```
mi[alpha]
```

[242]: 0.006628205346157046

1.31 Alpha 027

```
rank(((0 < ts_min(ts_delta(close, 1), 4))
? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 4) < 0)
    ? ts_delta(close, 1)
    : (-1 * ts_delta(close, 1)))))
```

[243]:
```
def alpha027(v, vwap):
    """((0.5 < rank(ts_mean(ts_corr(rank(volume), rank(vwap), 6), 2)))
            ? -1
            : 1)"""
    cond = rank(ts_mean(ts_corr(rank(v),
                                rank(vwap), 6), 2))
    alpha = cond.notnull().astype(float)
    return (alpha.where(cond <= 0.5, -alpha)
            .stack('ticker')
            .swaplevel())
```

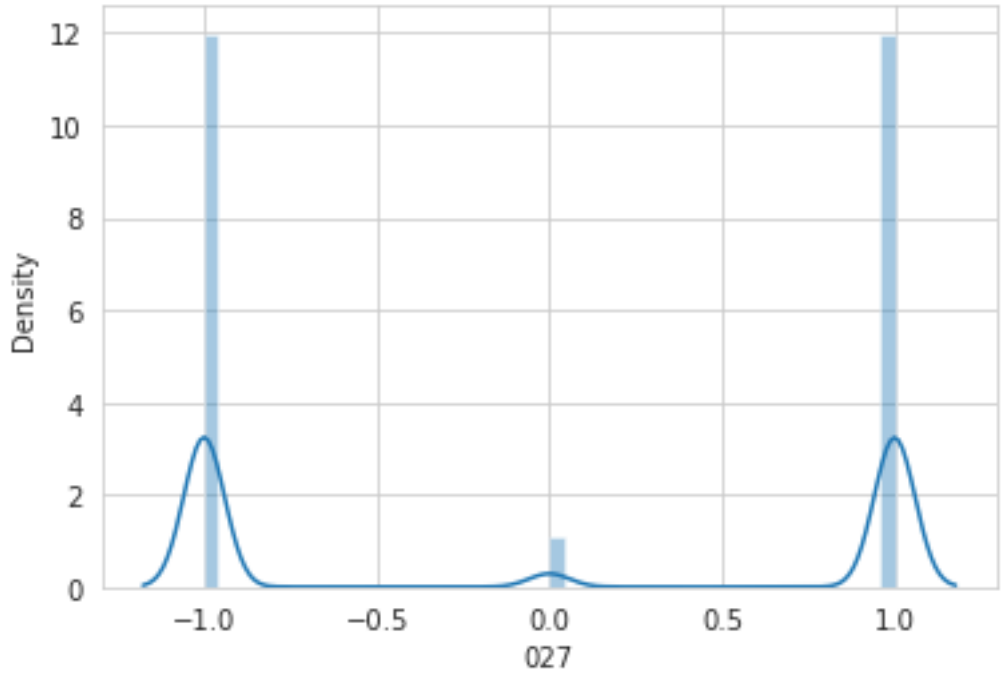
[244]:
```
alpha = 27
```

[245]:
```
%%time
alphas[f'{alpha:03}'] = alpha027(v, vwap)
```

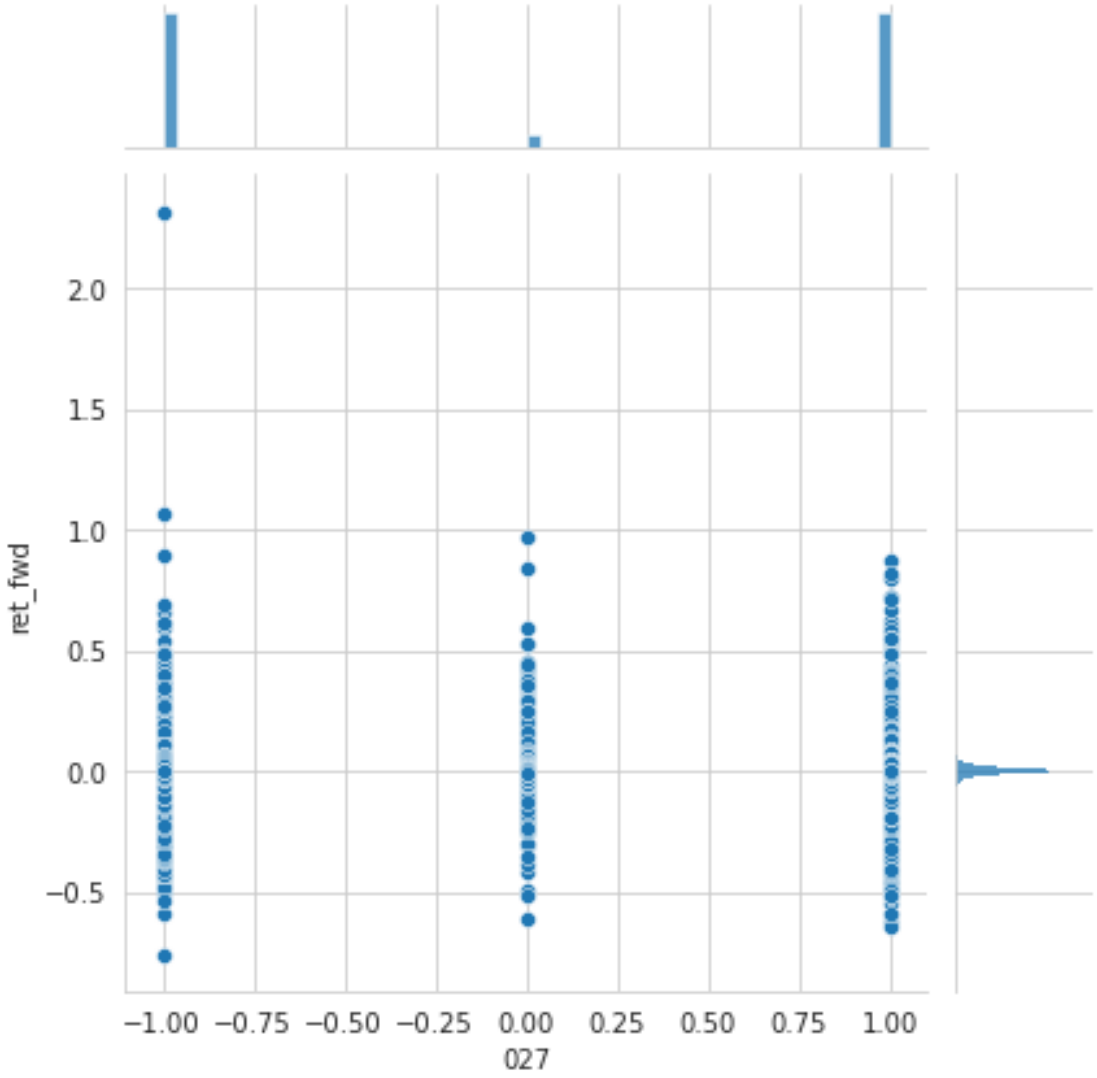
```
CPU times: user 3.65 s, sys: 28 ms, total: 3.68 s
Wall time: 3.64 s
```

[246]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[247]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[248]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[249]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[250]:
```
# mi[alpha]
```

1.32 Alpha 028

```
-rank((ts_std(abs((close - open)), 5) + (close - open)) +
           ts_corr(close, open,10))
```

[251]:
```
def alpha028(h, l, c, v, adv20):
    """scale(((ts_corr(adv20, low, 5) + (high + low) / 2) - close))"""
    return (scale(ts_corr(adv20, l, 5)
                  .replace([-np.inf, np.inf], 0)
                  .add(h.add(l).div(2).sub(c)))
```

```
            .stack('ticker')
            .swaplevel())
```

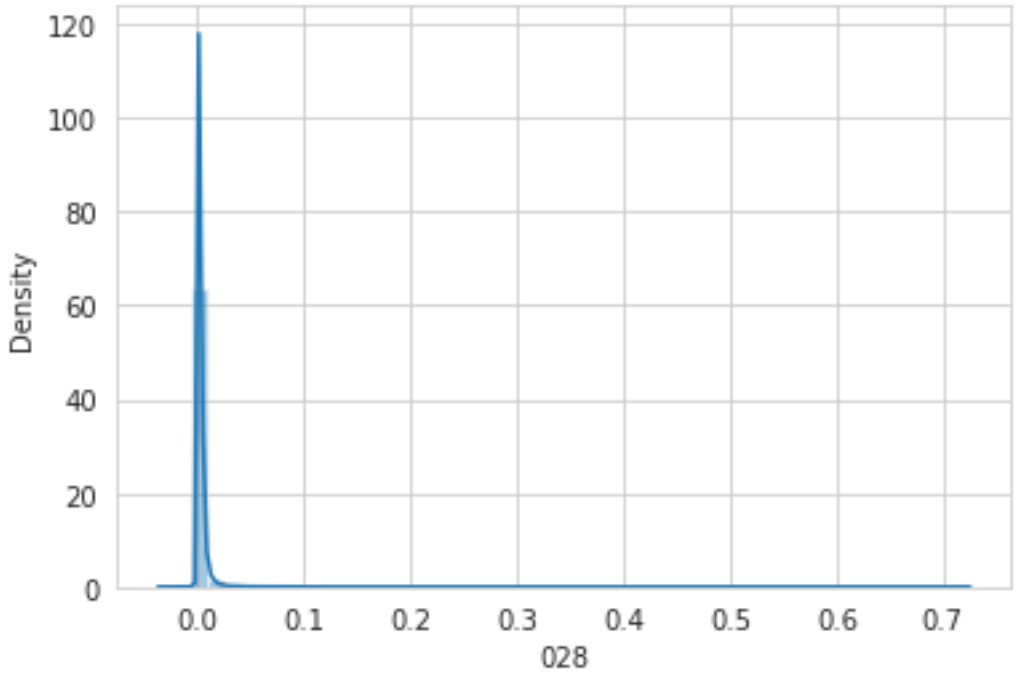
[252]:
```
alpha = 28
```

[253]:
```
%%time
alphas[f'{alpha:03}'] = alpha028(h, l, c, v, adv20)
```

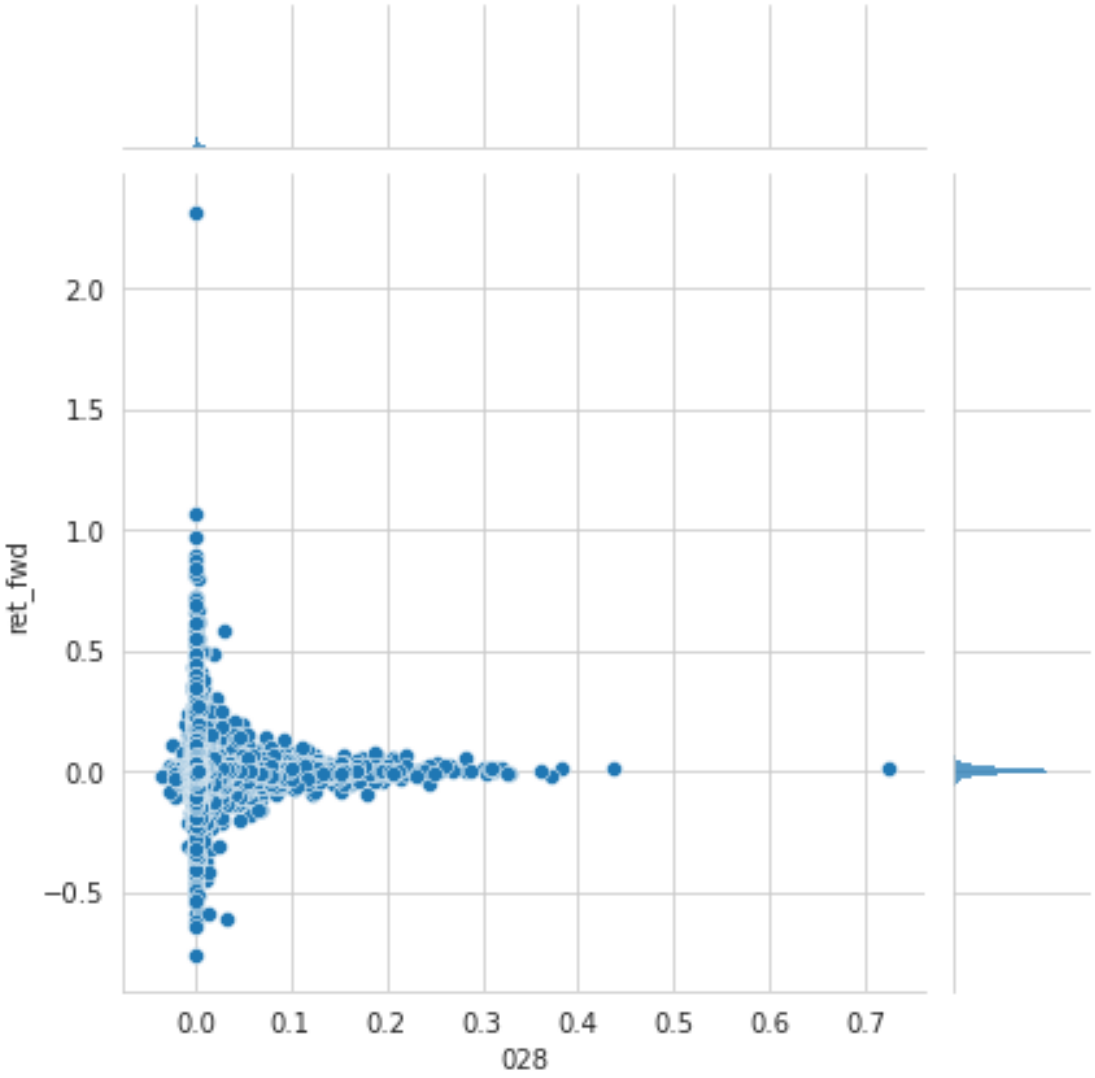
```
CPU times: user 3.3 s, sys: 24 ms, total: 3.33 s
Wall time: 3.27 s
```

[254]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[255]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[256]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[257]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[258]:
```
mi[alpha]
```

[258]: 0.0064583435249003784

[259]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.33 Alpha 029

```
rank(((0 < ts_min(ts_delta(close, 1), 4))
? ts_delta(close, 1)
: ((ts_max(ts_delta(close, 1), 4) < 0)
    ? ts_delta(close, 1)
```

```
    : (-1 * ts_delta(close, 1)))))
```

[260]:
```
def alpha029(c, r):
    """(ts_min(ts_product(rank(rank(scale(log(ts_sum(ts_min(rank(rank((-1 *
            rank(ts_delta((close - 1),5))))), 2), 1))))), 1), 5)
        + ts_rank(ts_lag((-1 * returns), 6), 5))
    """
    return (ts_min(rank(rank(scale(log(ts_sum(rank(rank(-rank(ts_delta((c - 1),␣
↪5)))), 2))))), 5)
            .add(ts_rank(ts_lag((-1 * r), 6), 5))
            .stack('ticker')
            .swaplevel())
```

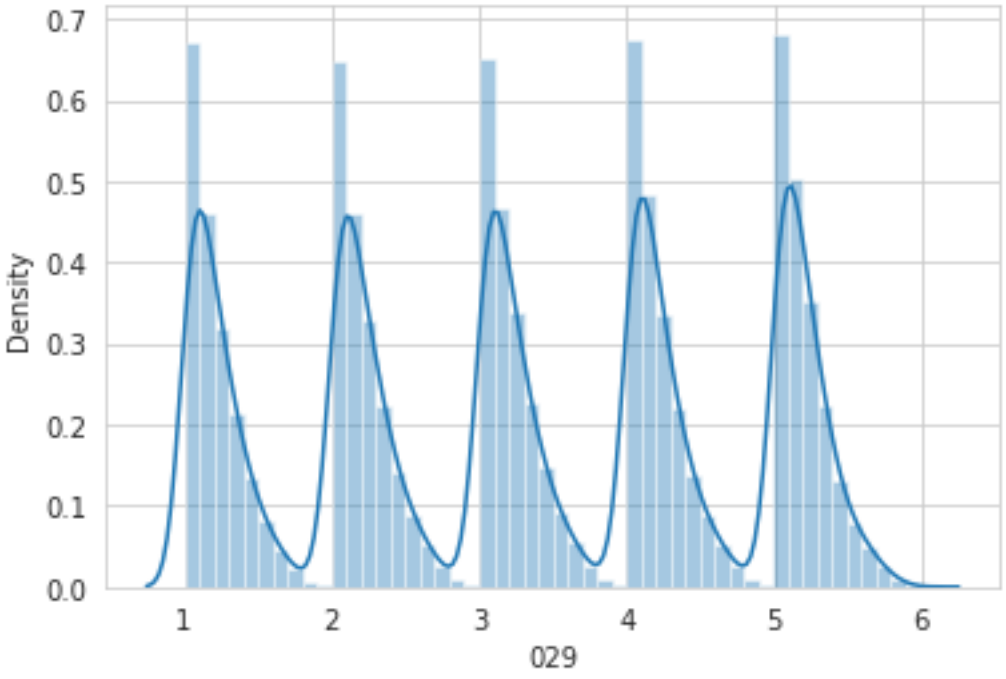
[261]:
```
alpha = 29
```

[262]:
```
%%time
alphas[f'{alpha:03}'] = alpha029(c, r)
```

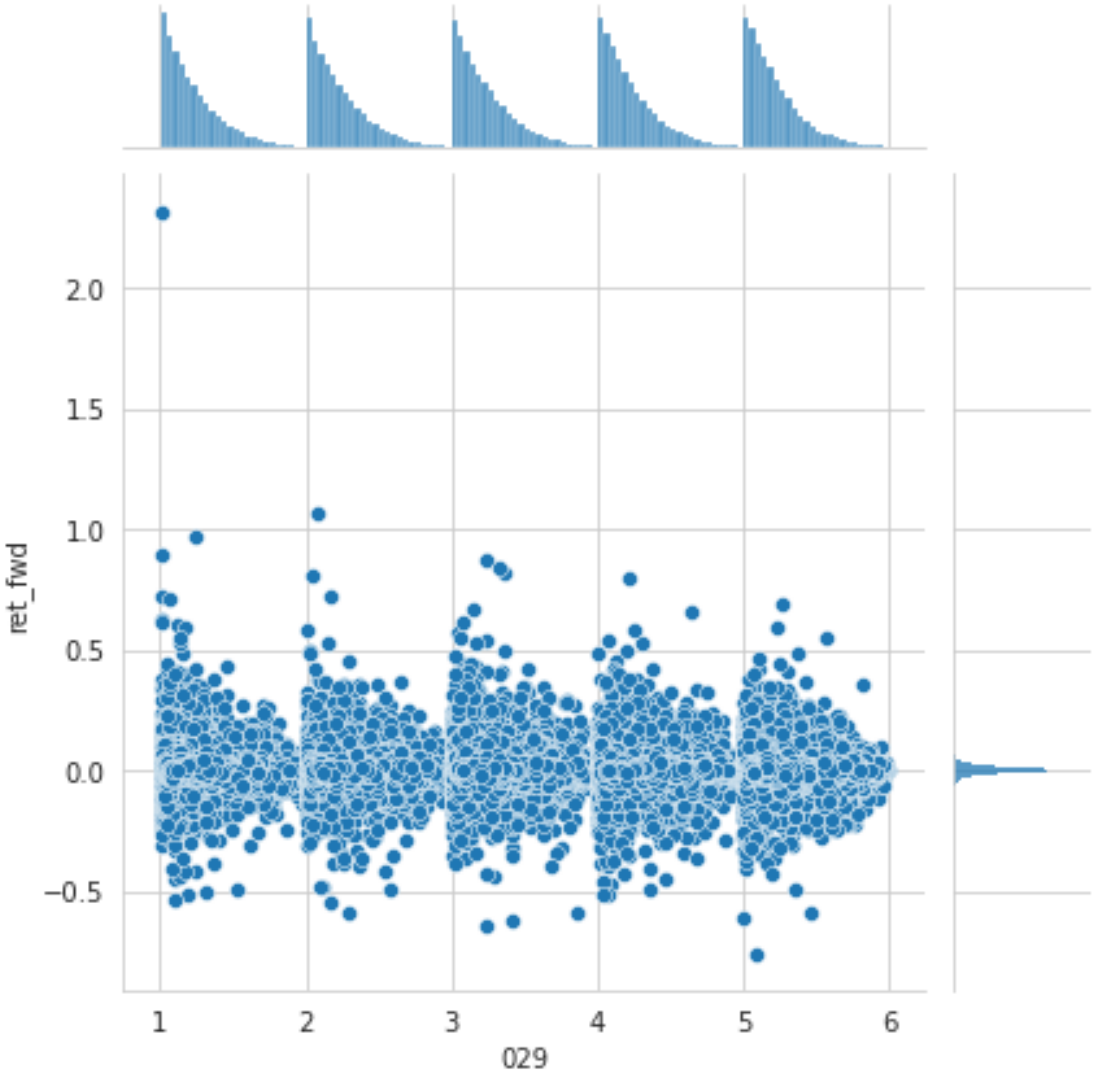
```
CPU times: user 3min 3s, sys: 188 ms, total: 3min 4s
Wall time: 3min 4s
```

[263]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[264]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[265]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[266]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[267]:
```
mi[alpha]
```

[267]: 0.005814612612969228

1.34 Alpha 030

```
-rank(open - ts_lag(high, 1)) *
 rank(open - ts_lag(close, 1)) *
 rank(open -ts_lag(low, 1))
```

[268]:
```
def alpha030(c, v):
    """(((1.0 - rank(((sign((close - ts_lag(close, 1))) +
            sign((ts_lag(close, 1) - ts_lag(close, 2)))) +
            sign((ts_lag(close, 2) - ts_lag(close, 3)))))) *
            ts_sum(volume, 5)) / ts_sum(volume, 20))"""
    close_diff = ts_delta(c, 1)
    return (rank(sign(close_diff)
                 .add(sign(ts_lag(close_diff, 1)))
                 .add(sign(ts_lag(close_diff, 2))))
            .mul(-1).add(1)
            .mul(ts_sum(v, 5))
            .div(ts_sum(v, 20))
            .stack('ticker')
            .swaplevel())
```

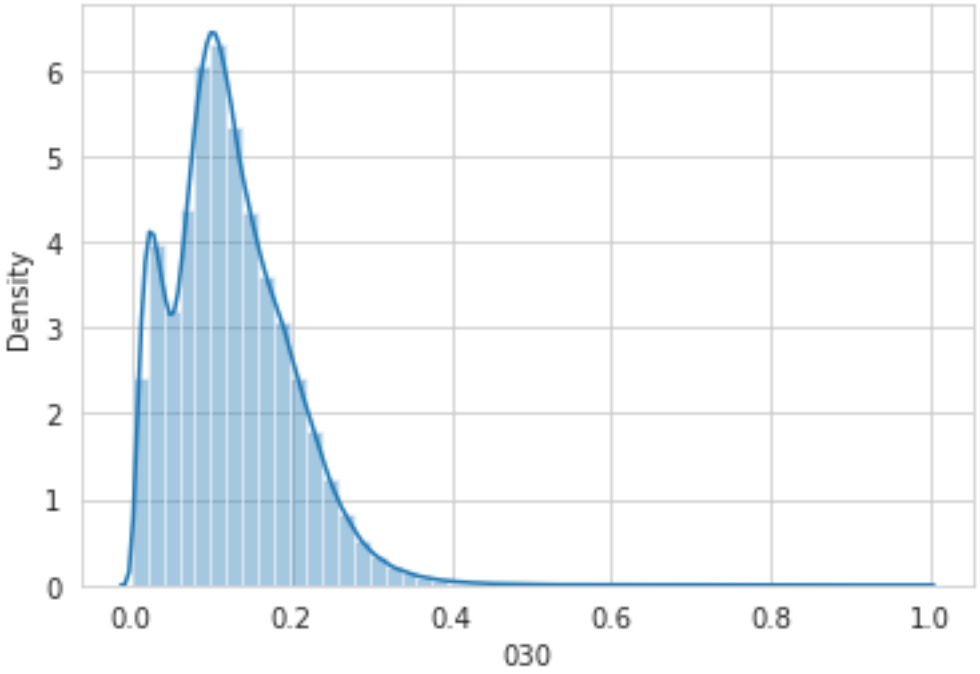
[269]:
```
alpha = 30
```

[270]:
```
%%time
alphas[f'{alpha:03}'] = alpha030(c, v)
```

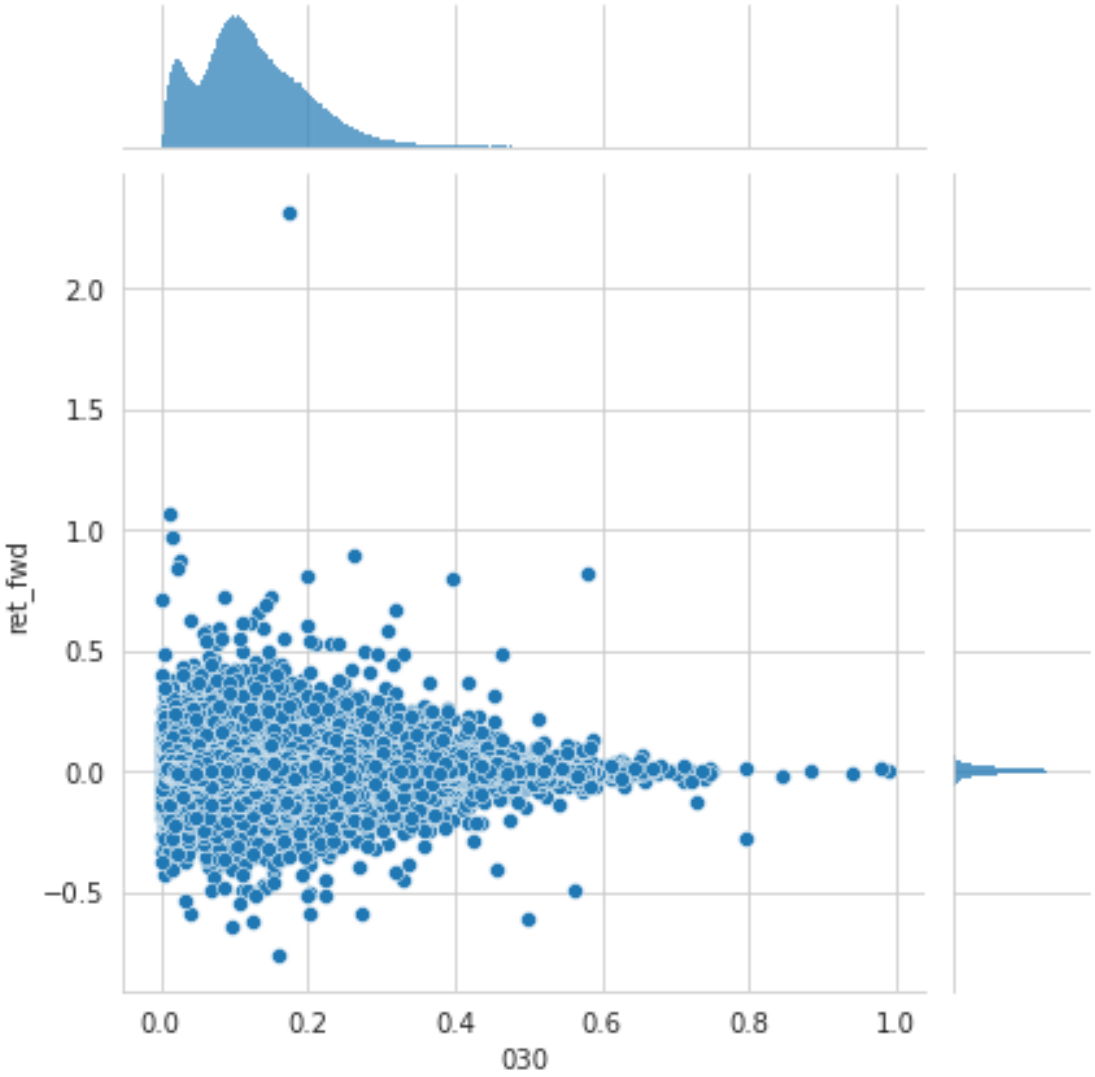
```
CPU times: user 2.39 s, sys: 48 ms, total: 2.44 s
Wall time: 2.38 s
```

[271]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[272]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[273]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[274]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[275]:
```
mi[alpha]
```

[275]: 0

1.35 Alpha 031

```
ts_mean(close, 8) + ts_std(close, 8) < ts_mean(close, 2)
        ? -1
```

```
        : (ts_mean(close,2) < ts_mean(close, 8) - ts_std(close, 8)
            ? 1
            : (volume / adv20 < 1
                ? -1
                : 1))
```

[276]:
```
def alpha031(l, c, adv20):
    """((rank(rank(rank(ts_weighted_mean((-1 * rank(rank(ts_delta(close,␣
↪10)))), 10)))) +
        rank((-1 * ts_delta(close, 3)))) + sign(scale(ts_corr(adv20, low, 12))))
    """
    return (rank(rank(rank(ts_weighted_mean(rank(rank(ts_delta(c, 10))).
↪mul(-1), 10))))
            .add(rank(ts_delta(c, 3).mul(-1)))
            .add(sign(scale(ts_corr(adv20, l, 12)
                            .replace([-np.inf, np.inf],
                                     np.nan))))
            .stack('ticker')
            .swaplevel())
```

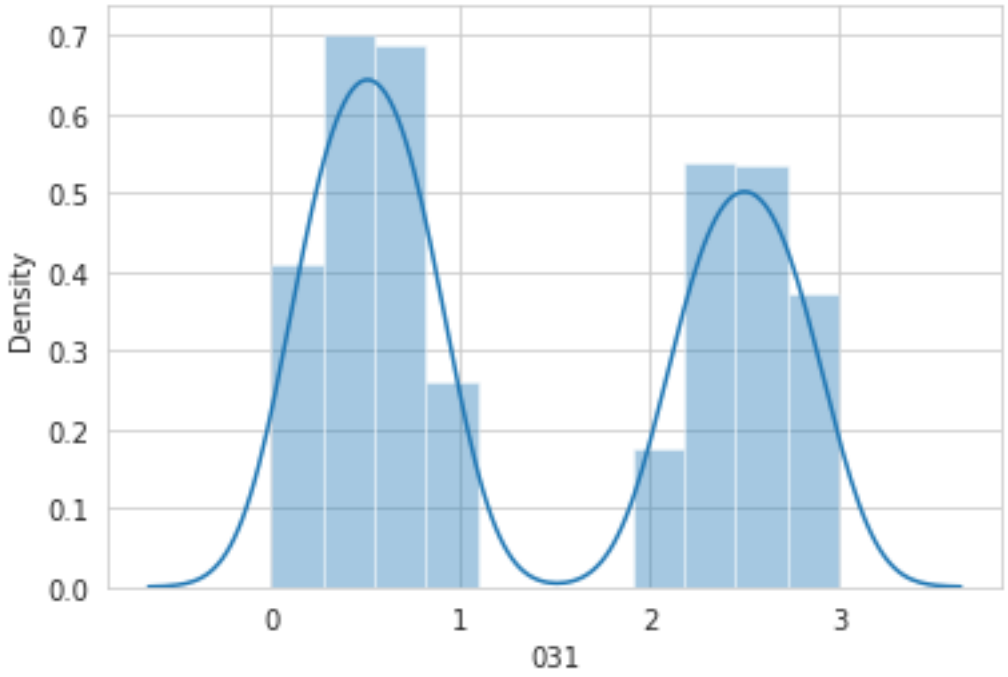
[277]:
```
alpha = 31
```

[278]:
```
%%time
alphas[f'{alpha:03}'] = alpha031(l, c, adv20)
```

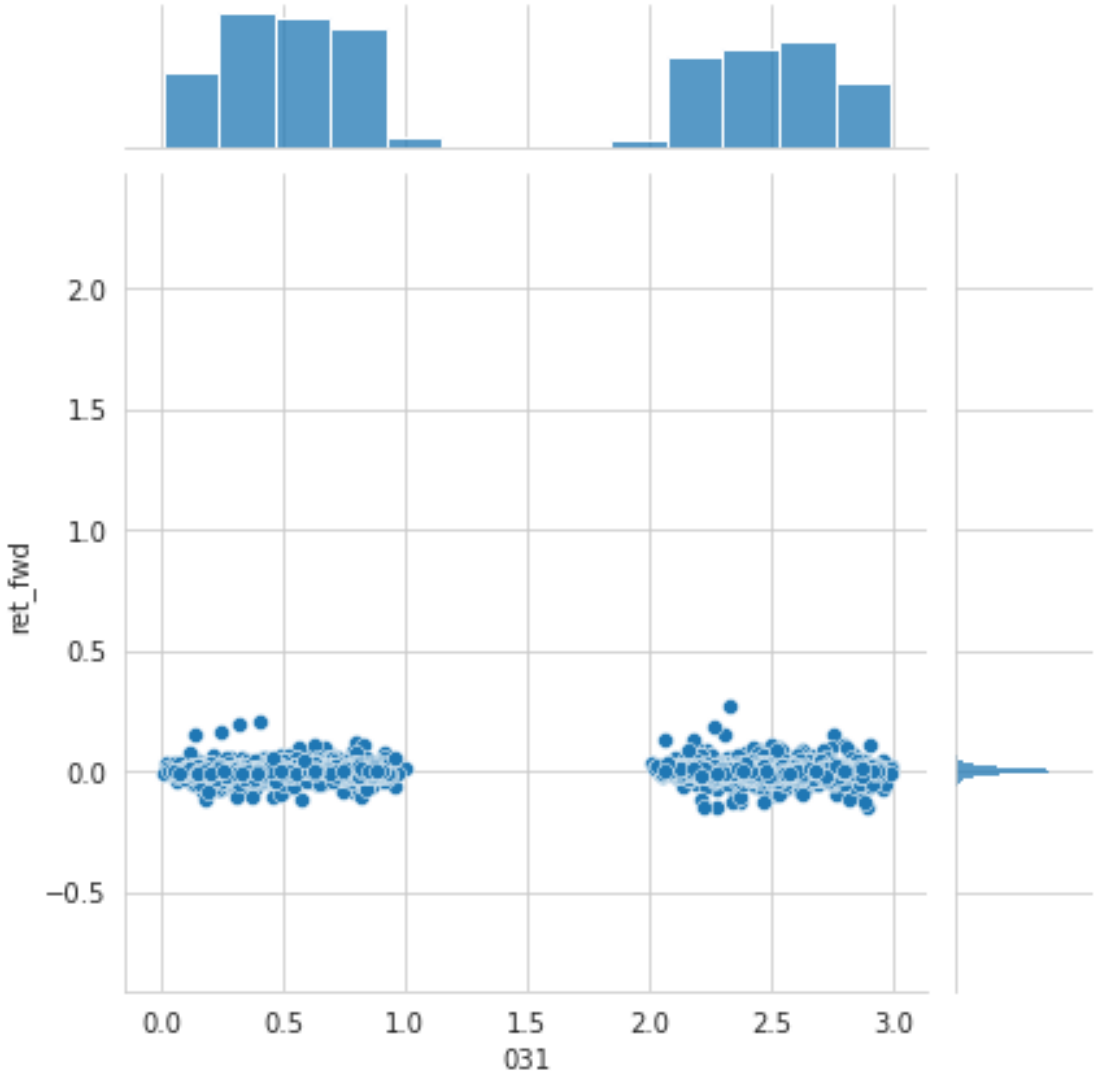
```
CPU times: user 3.66 s, sys: 15.9 ms, total: 3.68 s
Wall time: 3.61 s
```

[279]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[280]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[281]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.36 Alpha 032

scale(ts_mean(close, 7) - close) + (20 * scale(ts_corr(vwap, ts_lag(close, 5),230)))

[282]:
```
def alpha032(c, vwap):
    """scale(ts_mean(close, 7) - close) +
        (20 * scale(ts_corr(vwap, ts_lag(close, 5),230)))"""
    return (scale(ts_mean(c, 7).sub(c))
            .add(20 * scale(ts_corr(vwap,
                                    ts_lag(c, 5), 230)))
            .stack('ticker')
            .swaplevel())
```

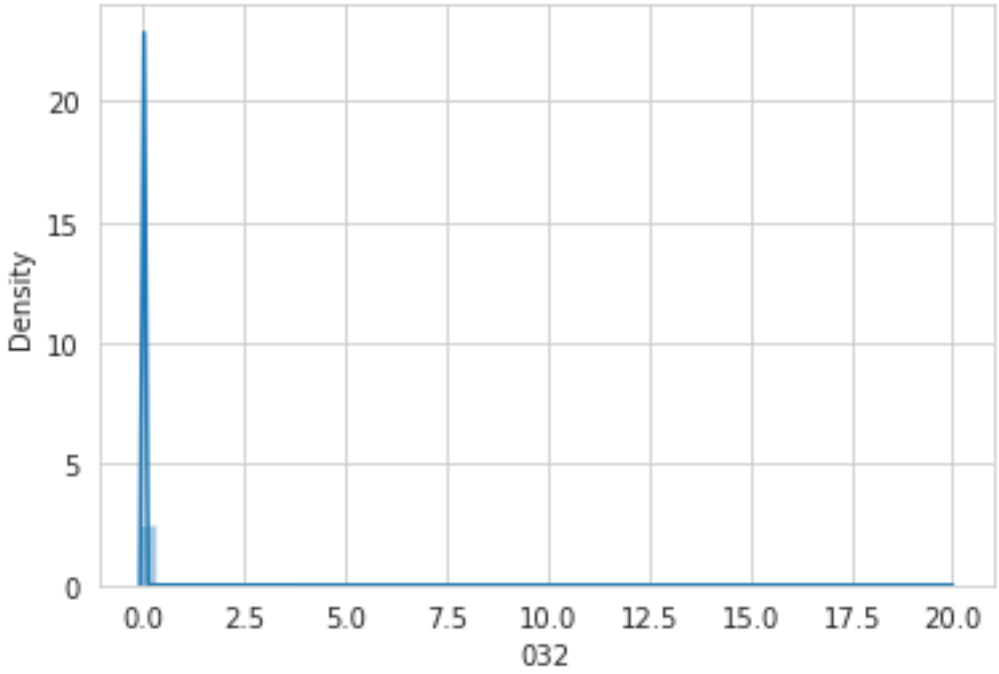
[283]:
```
alpha = 32
```

[284]:
```
%%time
alphas[f'{alpha:03}'] = alpha032(c, vwap)
```

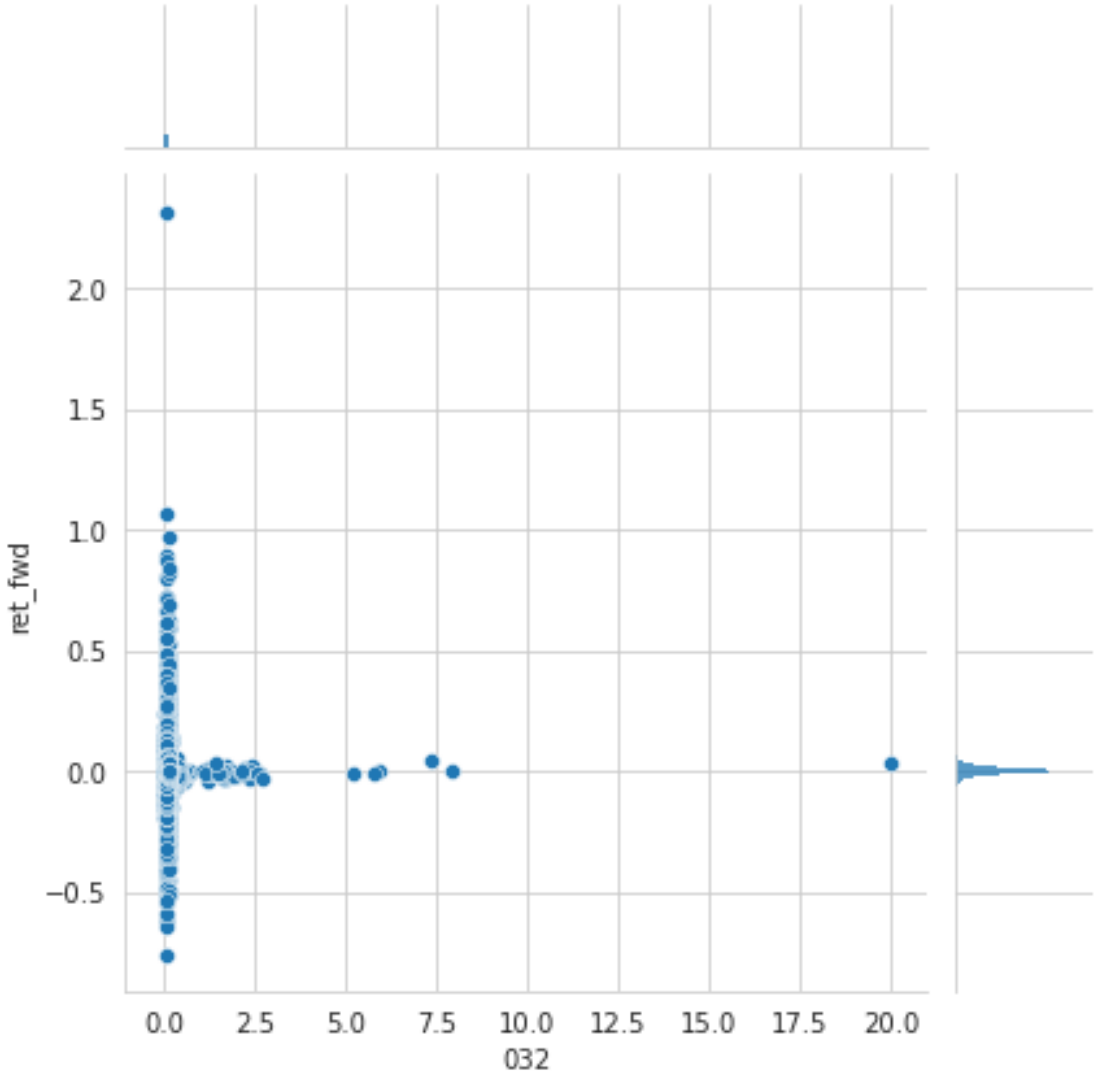
```
CPU times: user 3.68 s, sys: 15.9 ms, total: 3.69 s
Wall time: 3.63 s
```

[285]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[286]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[287]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[288]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd,
                                  alphas[f'{alpha:03}'])
```

[289]:
```
mi[alpha]
```

[289]: 0.015078606589863597

1.37 Alpha 033

```
((ts_sum(high, 20) / 20) < high)
            ? (-1 * ts_delta(high, 2))
            : 0
```

[290]:
```
def alpha033(o, c):
    """rank(-(1 - (open / close)))"""
    return (rank(o.div(c).mul(-1).add(1).mul(-1))
            .stack('ticker')
            .swaplevel())
```

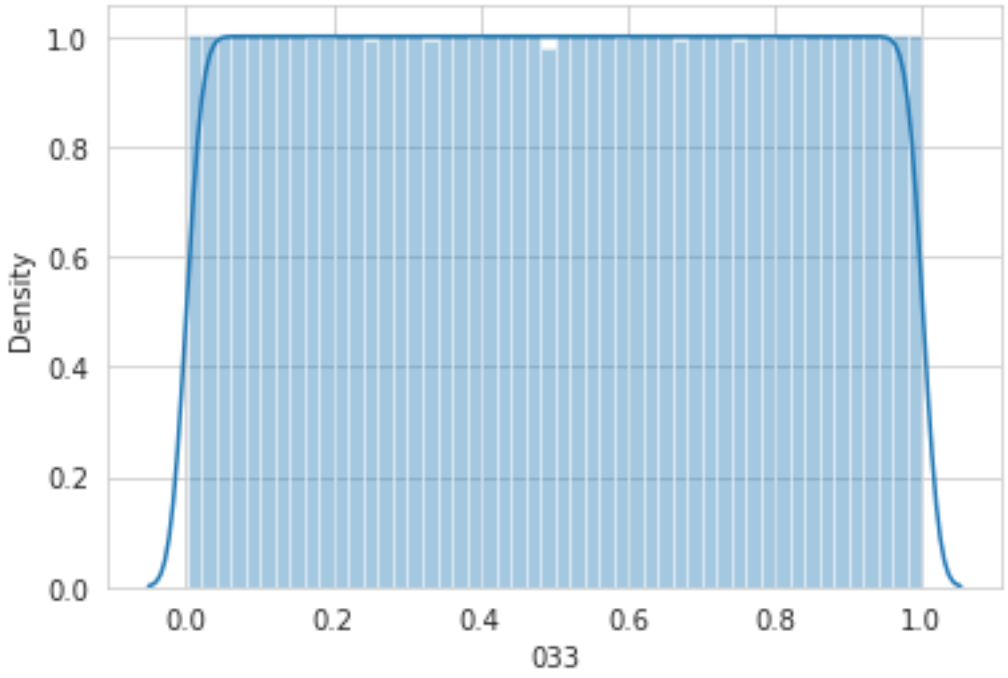
[291]:
```
alpha = 33
```

[292]:
```
%%time
alphas[f'{alpha:03}'] = alpha033(o, c)
```

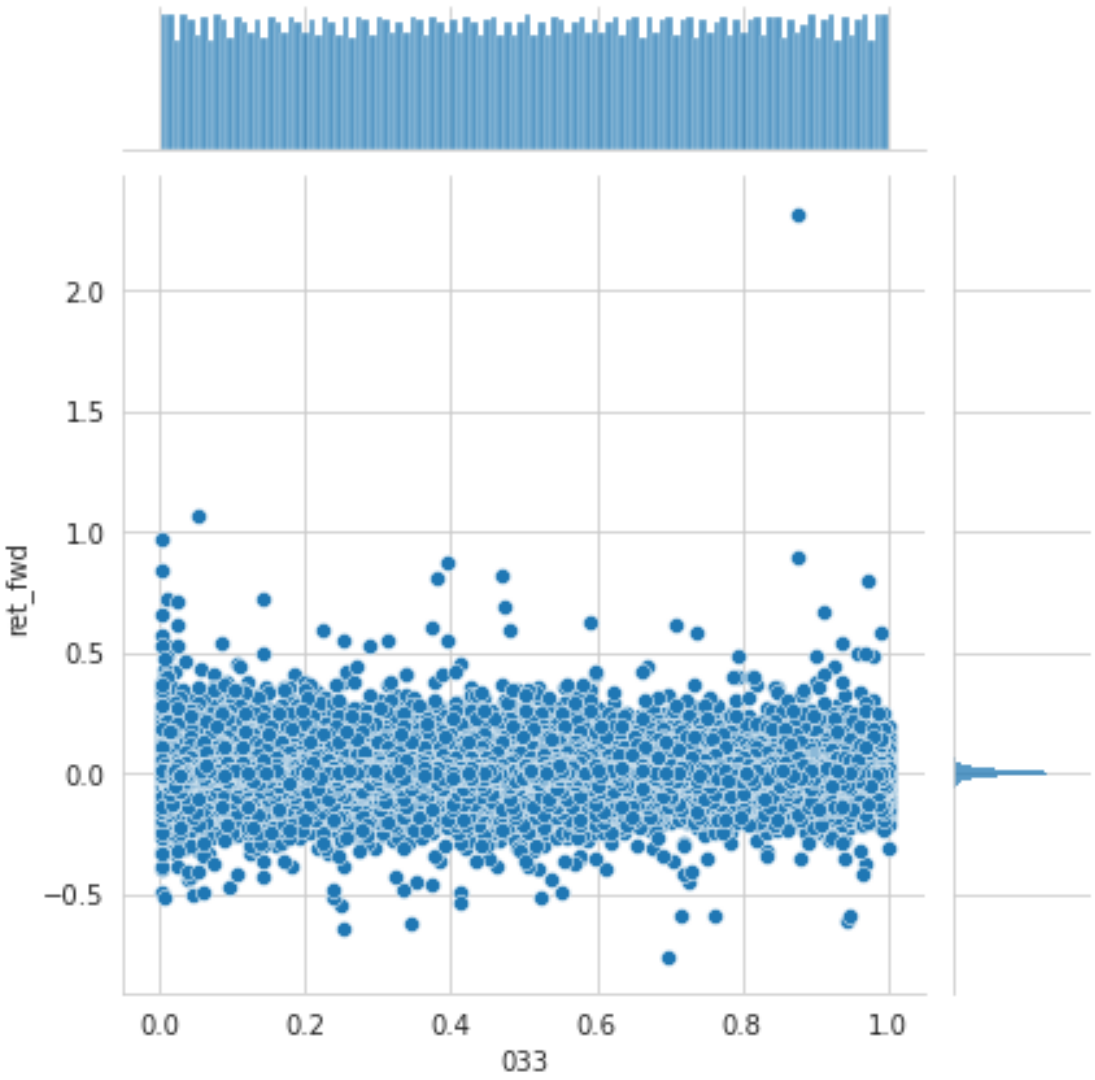
```
CPU times: user 2.66 s, sys: 12 ms, total: 2.67 s
Wall time: 2.64 s
```

[293]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[294]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[295]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[296]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[297]:
```
mi[alpha]
```

[297]: 0.003290483361809038

1.38 Alpha 034

```
((((ts_delta((ts_mean(close, 100)), 100) / ts_lag(close, 100)) <= 0.05)
        ? (-1 * (close - ts_min(close, 100)))
        : (-1 * ts_delta(close, 3)))
```

[298]:
```
def alpha034(c, r):
    """rank(((1 - rank((ts_std(returns, 2) / ts_std(returns, 5)))) + (1 -␣
 ↪rank(ts_delta(close, 1)))))"""

    return (rank(rank(ts_std(r, 2).div(ts_std(r, 5))
                      .replace([-np.inf, np.inf],
                               np.nan))
                 .mul(-1)
                 .sub(rank(ts_delta(c, 1)))
                 .add(2))
            .stack('ticker')
            .swaplevel())
```

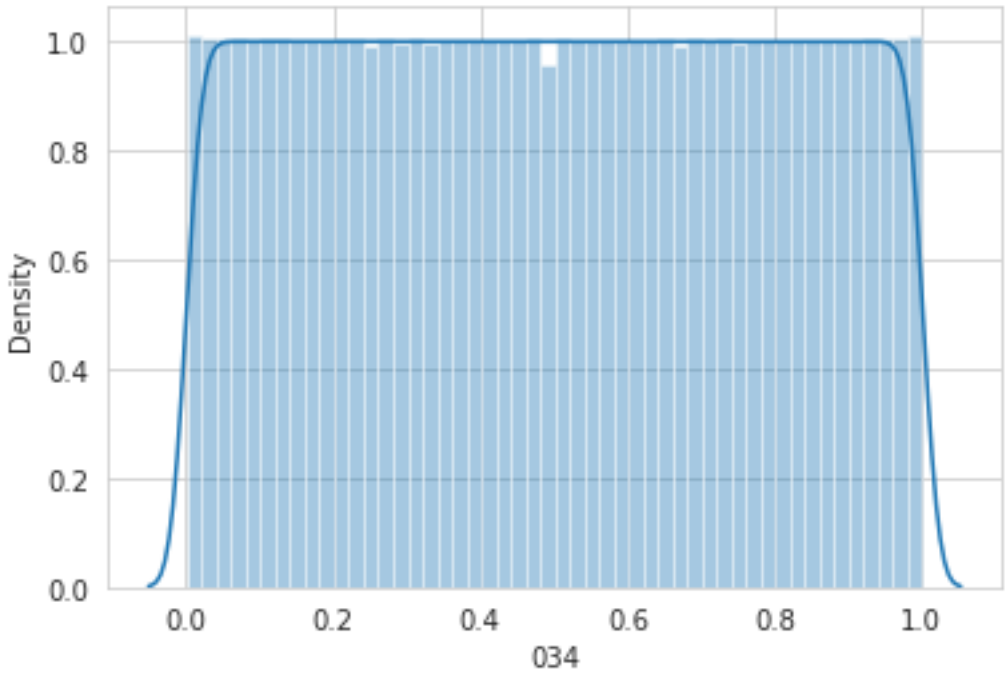
[299]:
```
alpha = 34
```

[300]:
```
%%time
alphas[f'{alpha:03}'] = alpha034(c, r)
```

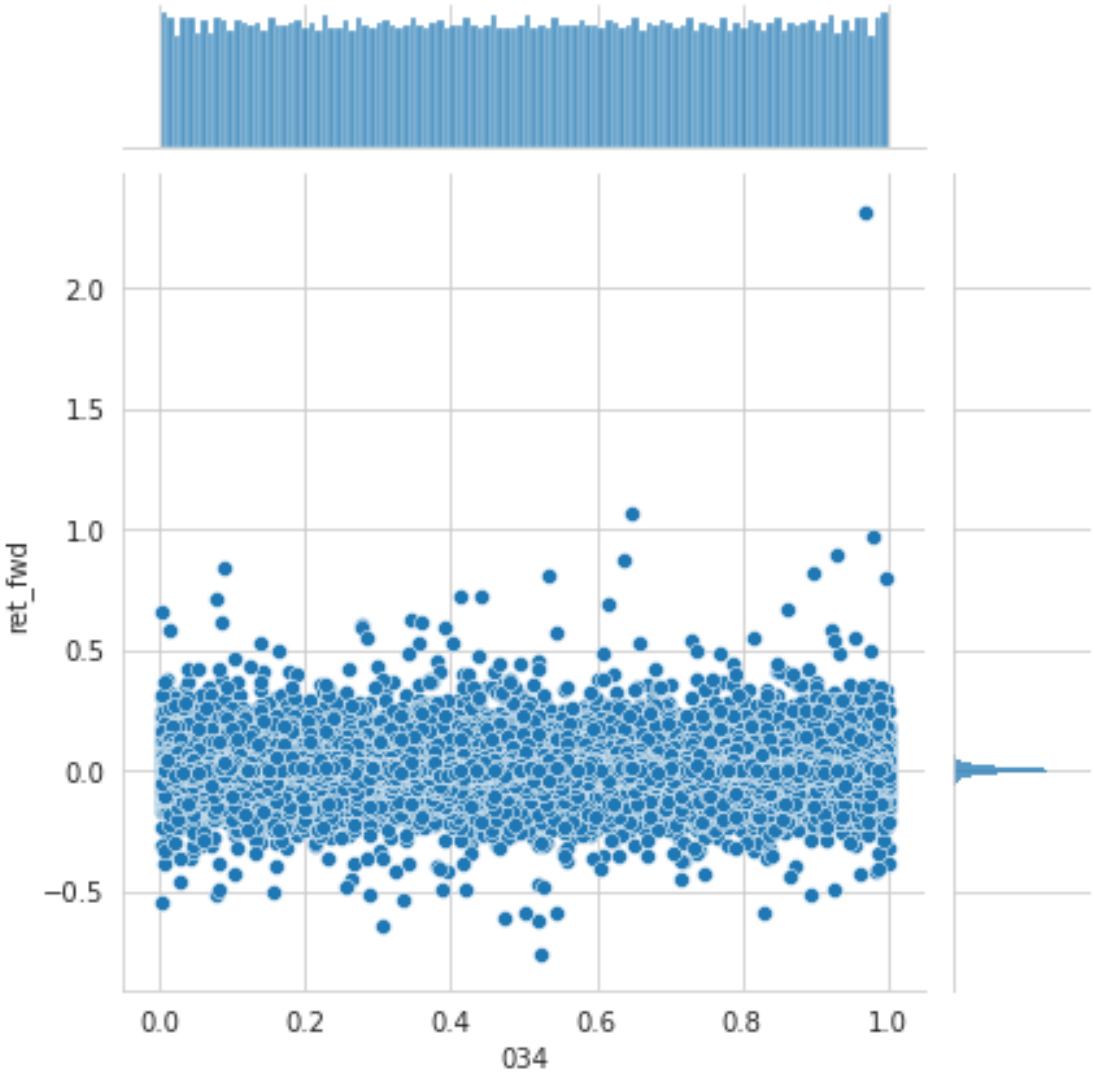
```
CPU times: user 1.75 s, sys: 8 ms, total: 1.76 s
Wall time: 1.73 s
```

[301]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[302]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[303]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[304]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[305]:
```
mi[alpha]
```

[305]: 0

[306]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.39 Alpha 035

`rank((-1 * returns) * adv20 * vwap * (high - close))`

[307]:
```
def alpha035(h, l, c, v, r):
    """((ts_Rank(volume, 32) *
        (1 - ts_Rank(((close + high) - low), 16))) *
        (1 -ts_Rank(returns, 32)))
    """
    return (ts_rank(v, 32)
            .mul(1 - ts_rank(c.add(h).sub(l), 16))
            .mul(1 - ts_rank(r, 32))
            .stack('ticker')
            .swaplevel())
```

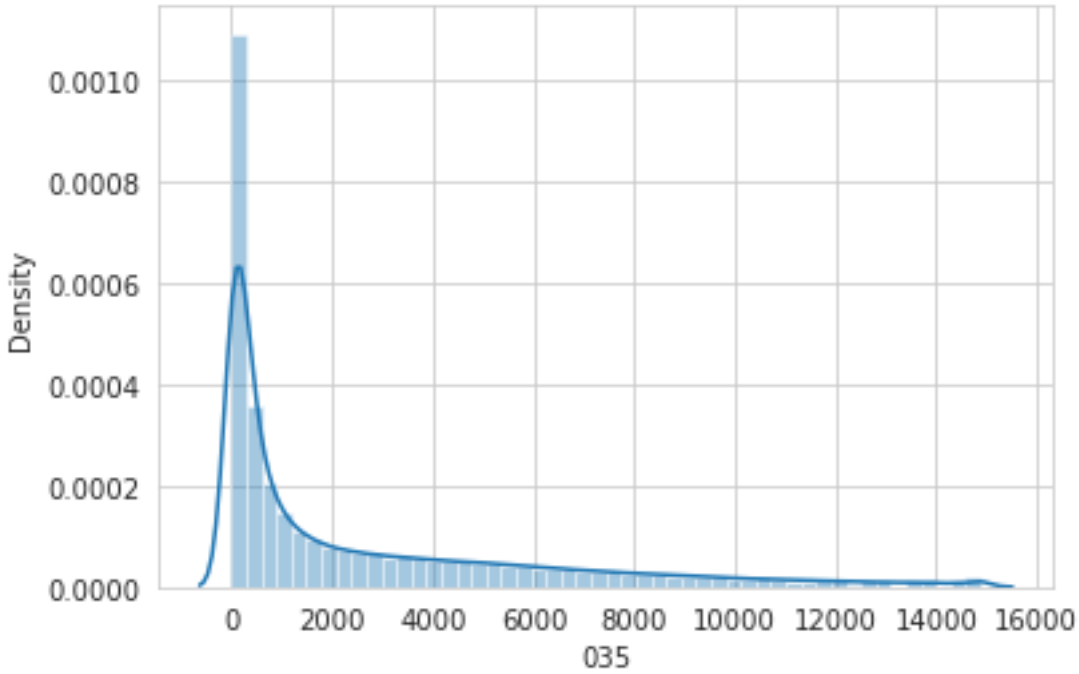
[308]:
```
alpha = 35
```

[309]:
```
%%time
alphas[f'{alpha:03}'] = alpha035(h, l, c, v, r)
```

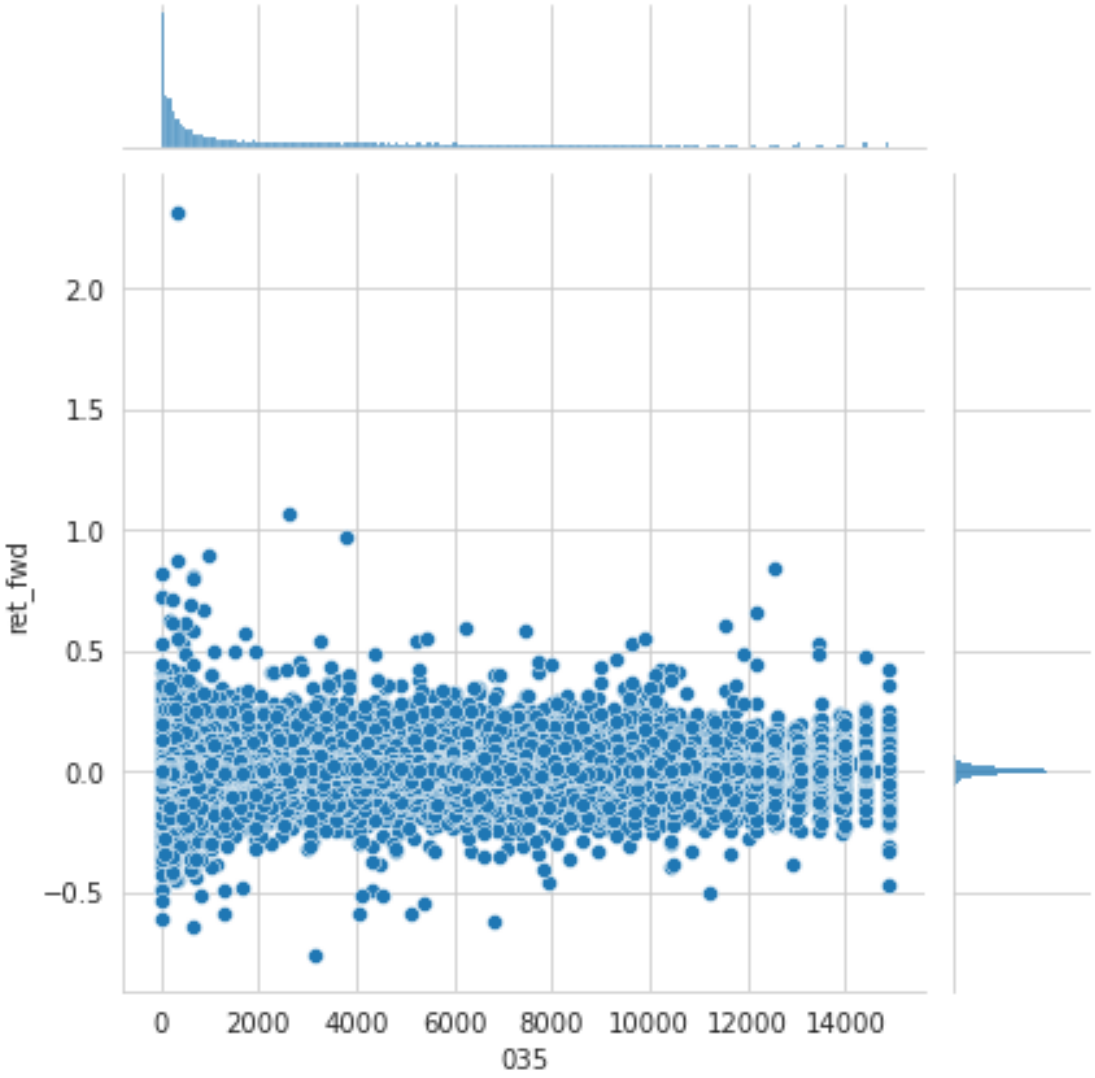
```
CPU times: user 9min 1s, sys: 95.8 ms, total: 9min 1s
Wall time: 9min 1s
```

[310]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[311]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[312]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[313]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[314]:
```
mi[alpha]
```

[314]: 0

1.40 Alpha 036

```
2.21 * rank(ts_corr((close - open), ts_lag(volume, 1), 15)) +
0.7 * rank((open- close)) +
0.73 * rank(ts_Rank(ts_lag(-1 * returns, 6), 5)) +
rank(abs(ts_corr(vwap,adv20, 6))) +
0.6 * rank(((ts_mean(close, 200) - open) * (close - open)))
```

[315]:
```
def alpha036(o, c, v, r, adv20):
    """2.21 * rank(ts_corr((close - open), ts_lag(volume, 1), 15)) +
        0.7 * rank((open- close)) +
        0.73 * rank(ts_Rank(ts_lag(-1 * returns, 6), 5)) +
        rank(abs(ts_corr(vwap,adv20, 6))) +
        0.6 * rank(((ts_mean(close, 200) - open) * (close - open)))
    """

    return (rank(ts_corr(c.sub(o), ts_lag(v, 1), 15)).mul(2.21)
            .add(rank(o.sub(c)).mul(.7))
            .add(rank(ts_rank(ts_lag(-r, 6), 5)).mul(0.73))
            .add(rank(abs(ts_corr(vwap, adv20, 6))))
            .add(rank(ts_mean(c, 200).sub(o).mul(c.sub(o))).mul(0.6))
            .stack('ticker')
            .swaplevel())
```

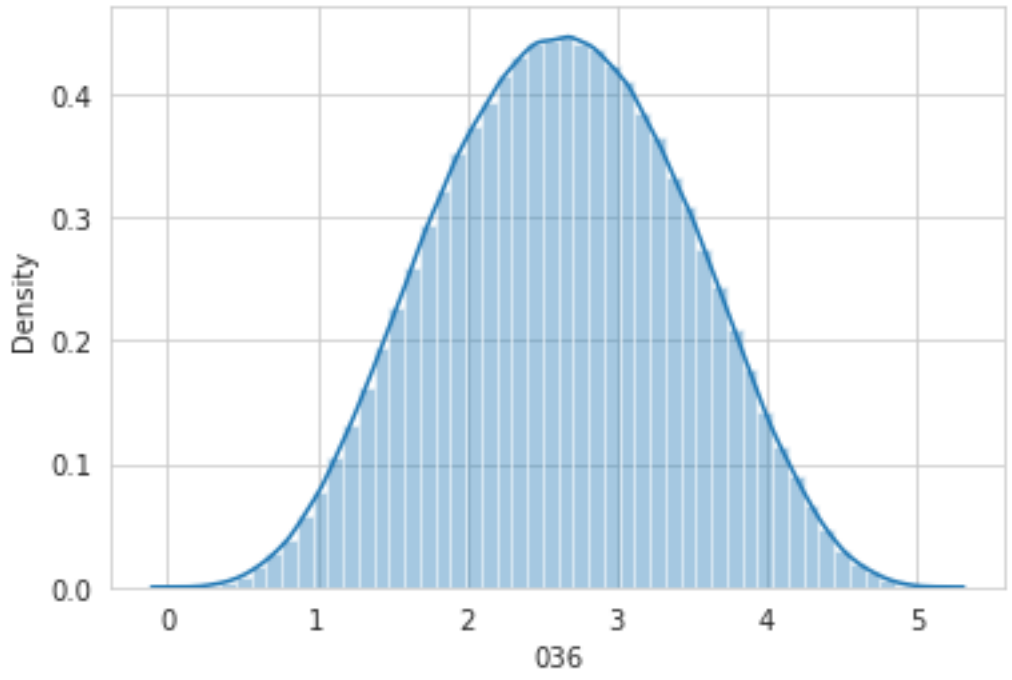
[316]:
```
alpha = 36
```

[317]:
```
%%time
alphas[f'{alpha:03}'] = alpha036(o, c, v, r, adv20)
```

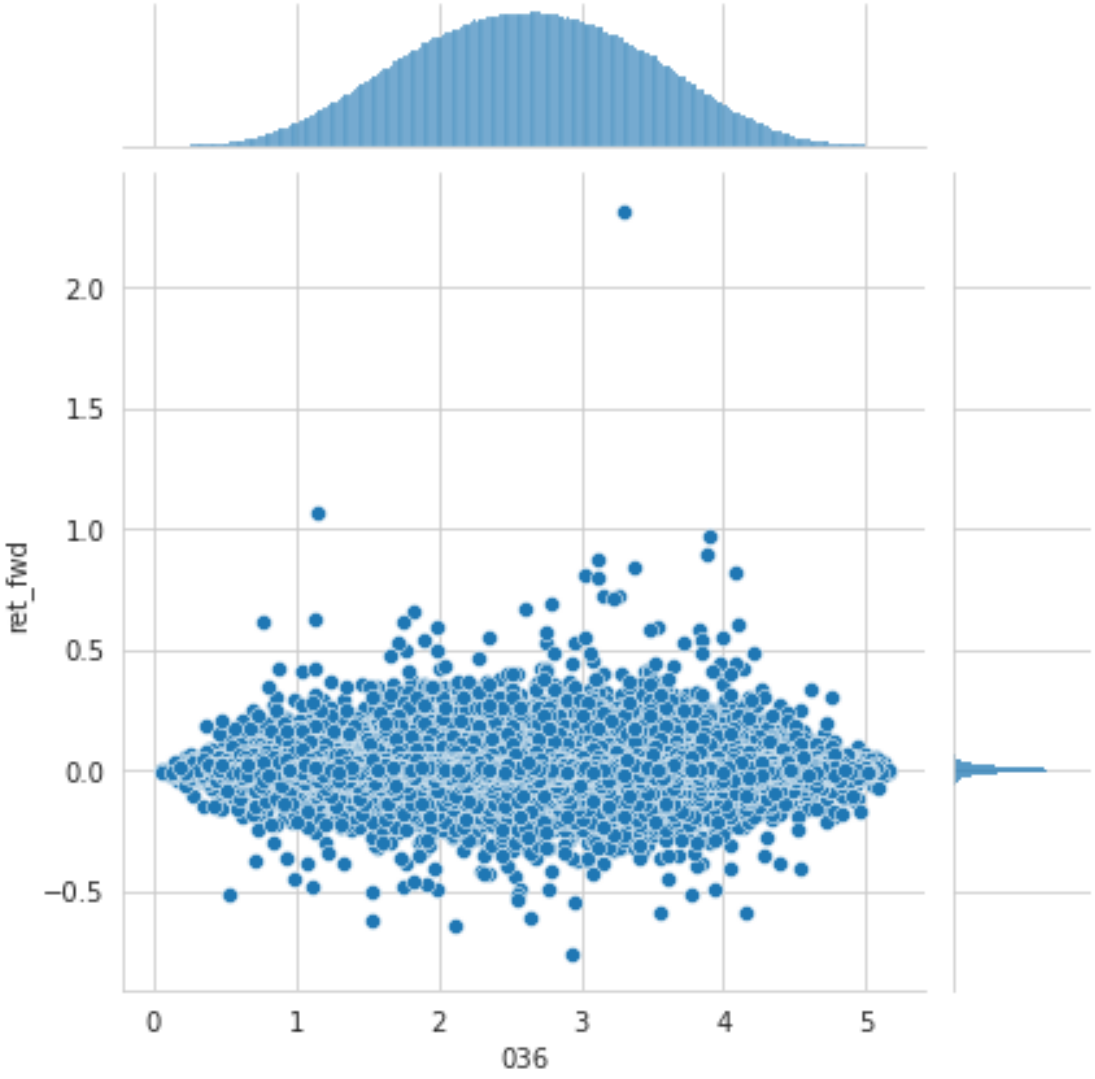
```
CPU times: user 3min 5s, sys: 51.9 ms, total: 3min 5s
Wall time: 3min 5s
```

[318]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[319]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[320]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[321]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[322]:
```
mi[alpha]
```

[322]:
```
0.0017091501300177114
```

1.41 Alpha 037

```
rank(ts_corr(ts_lag(open - close, 1), close, 200)) +
```

rank(open - close)

[323]:
```
def alpha037(o, c):
    """(rank(ts_corr(ts_lag((open - close), 1), close, 200)) + rank((open -␣
 ↪close)))"""
    return (rank(ts_corr(ts_lag(o.sub(c), 1), c, 200))
            .add(rank(o.sub(c)))
            .stack('ticker')
            .swaplevel())
```

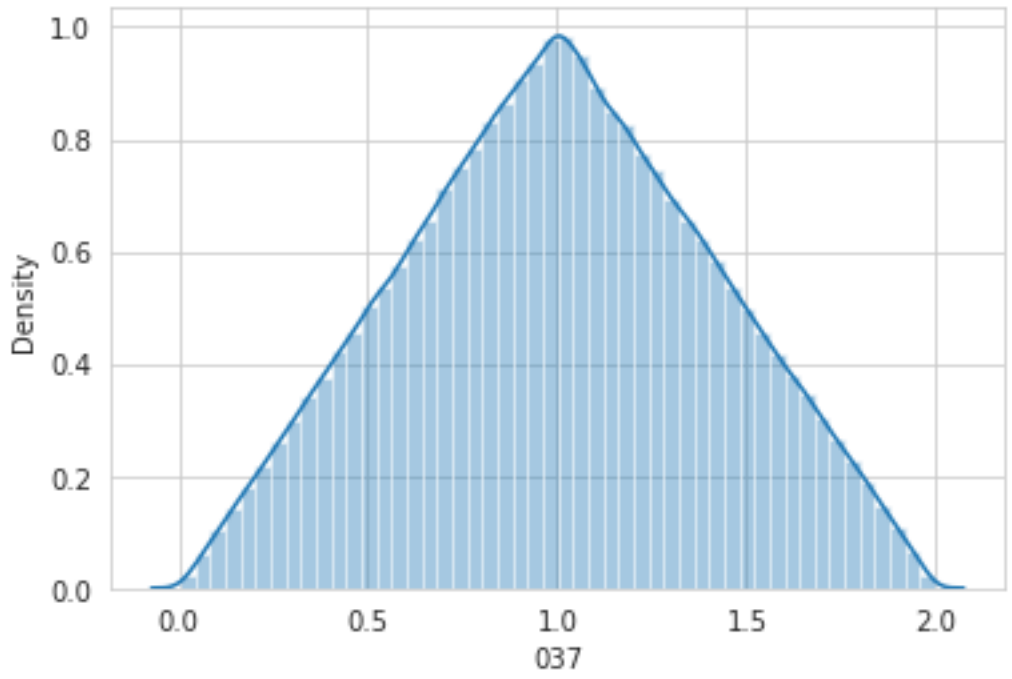
[324]:
```
alpha = 37
```

[325]:
```
%%time
alphas[f'{alpha:03}'] = alpha037(o, c)
```

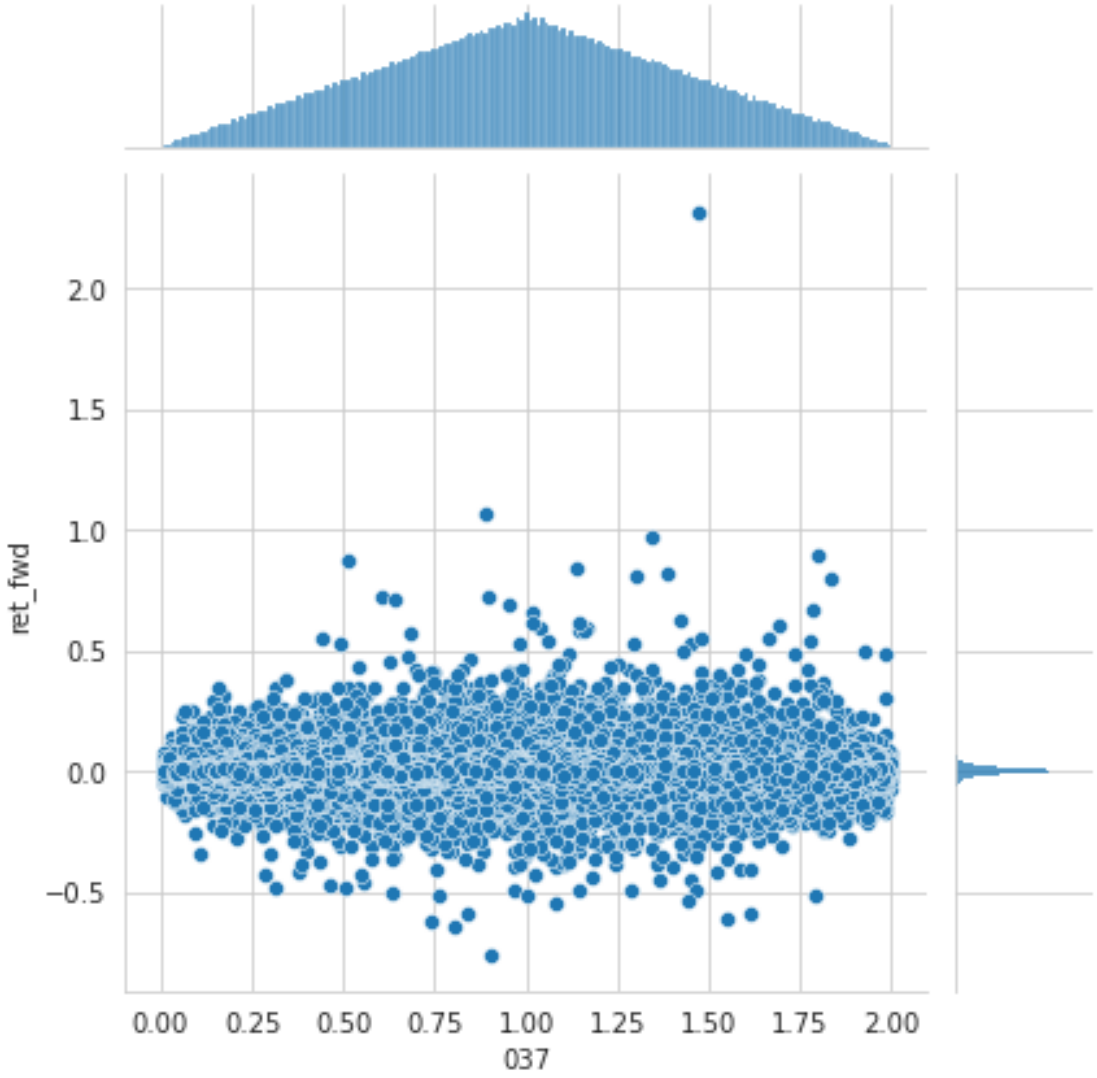
```
CPU times: user 3.51 s, sys: 32 ms, total: 3.54 s
Wall time: 3.49 s
```

[326]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[327]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[328]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[329]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[330]:
```
mi[alpha]
```

[330]: 0.0011419189372663396

[331]:
```
pd.Series(mi).to_csv('mi.csv')
```

1.42 Alpha 038

```
1 * rank(ts_rank(close, 10)) * rank(close / open)
```

[332]:
```
def alpha038(o, c):
    """-1 * rank(ts_rank(close, 10)) * rank(close / open)"""
    return (rank(ts_rank(o, 10))
            .mul(rank(c.div(o).replace([-np.inf, np.inf], np.nan)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

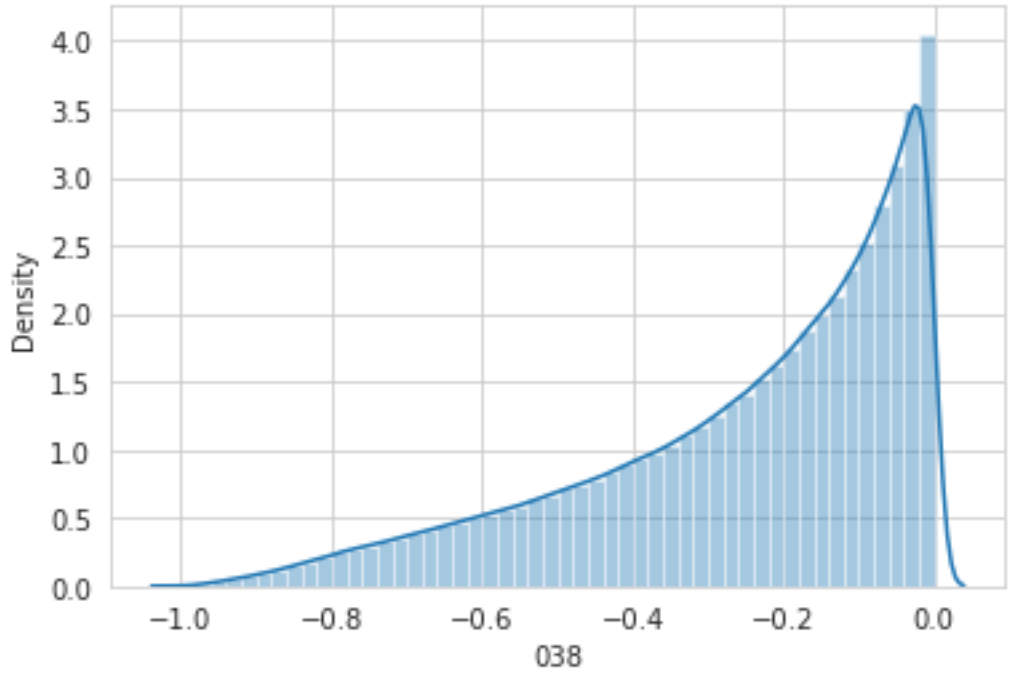
[333]:
```
alpha = 38
```

[334]:
```
%%time
alphas[f'{alpha:03}'] = alpha038(o, c)
```

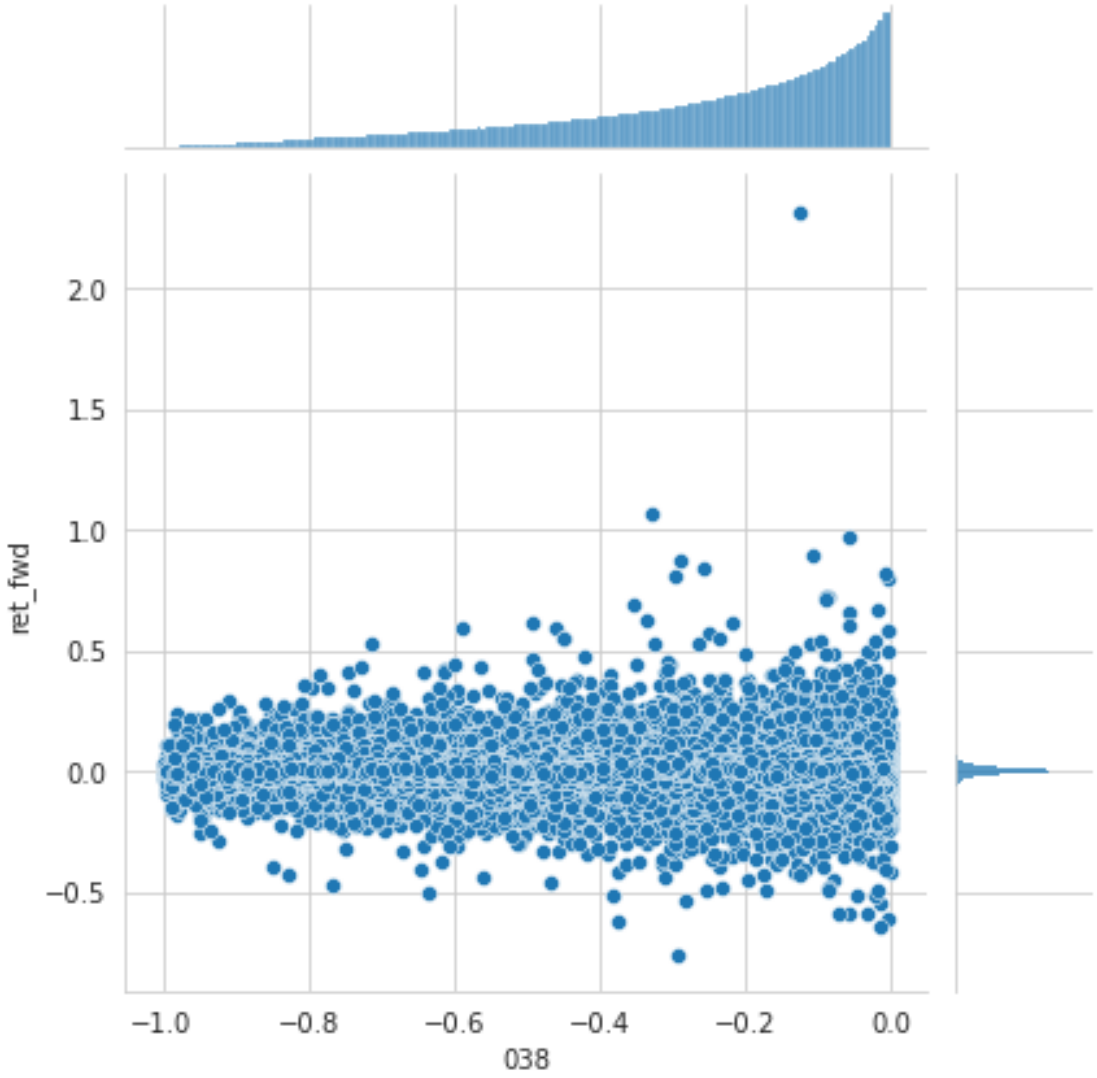
```
CPU times: user 3min 5s, sys: 15.9 ms, total: 3min 5s
Wall time: 3min 5s
```

[335]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[336]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[337]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[338]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[339]:
```
mi[alpha]
```

[339]: 0.003271738846891026

1.43 Alpha 039

```
-rank(ts_delta(close, 7) * (1 - rank(ts_weighted_mean(volume / adv20, 9)))) *
    (1 + rank(ts_sum(returns, 250)))
```

[340]:
```
def alpha039(c, v, r, adv20):
    """-rank(ts_delta(close, 7) * (1 - rank(ts_weighted_mean(volume / adv20,␣
↪9)))) *
```

```
            (1 + rank(ts_sum(returns, 250)))"""
    return (rank(ts_delta(c, 7).mul(rank(ts_weighted_mean(v.div(adv20), 9)).
↪mul(-1).add(1))).mul(-1)
            .mul(rank(ts_mean(r, 250).add(1)))
            .stack('ticker')
            .swaplevel())
```

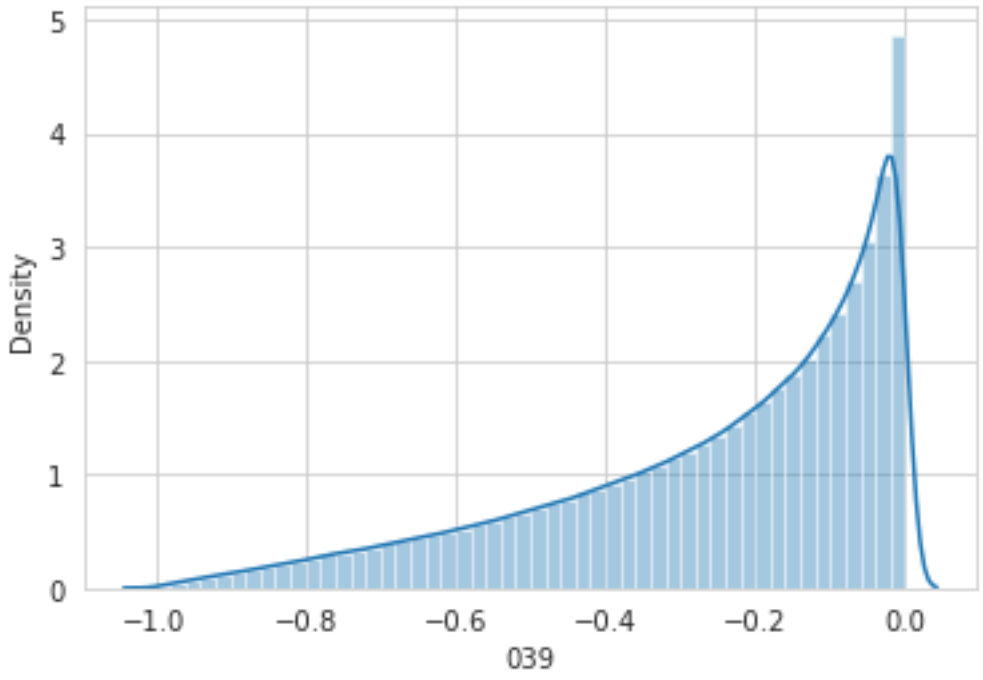
[341]:
```
alpha = 39
```

[342]:
```
%%time
alphas[f'{alpha:03}'] = alpha039(c, v, r, adv20)
```

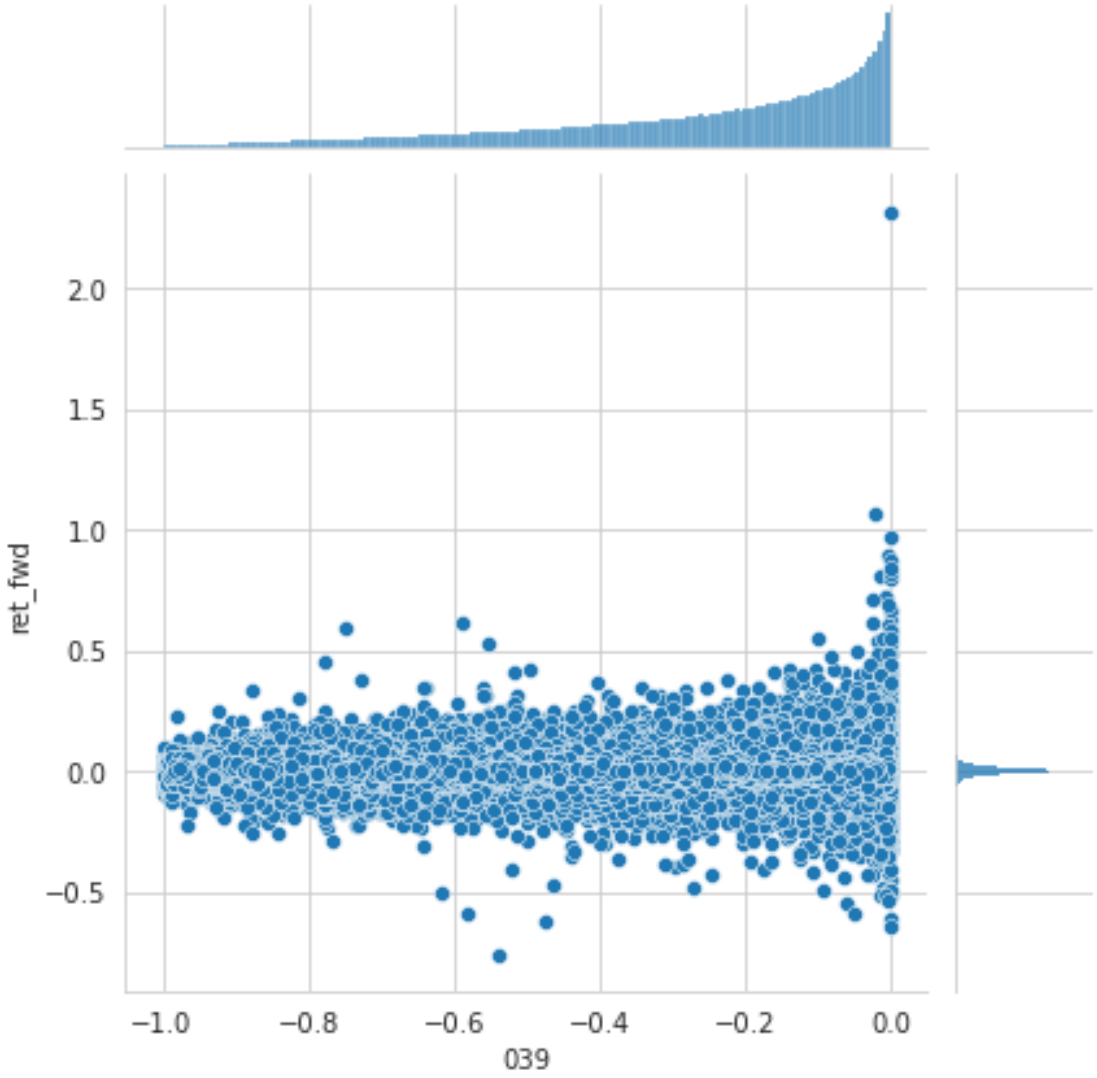
```
CPU times: user 2.55 s, sys: 16 ms, total: 2.56 s
Wall time: 2.5 s
```

[343]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[344]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[345]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[346]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
```

[347]:
```
mi[alpha]
```

[347]: 0.0021417818275919487

1.44 Alpha 040

```
-rank(open - ts_lag(high, 1)) *
 rank(open - ts_lag(close, 1)) *
 rank(open -ts_lag(low, 1))
```

[348]:
```
def alpha040(h, v):
    """((-1 * rank(ts_std(high, 10))) * ts_corr(high, volume, 10))
    """
    return (rank(ts_std(h, 10))
            .mul(ts_corr(h, v, 10))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

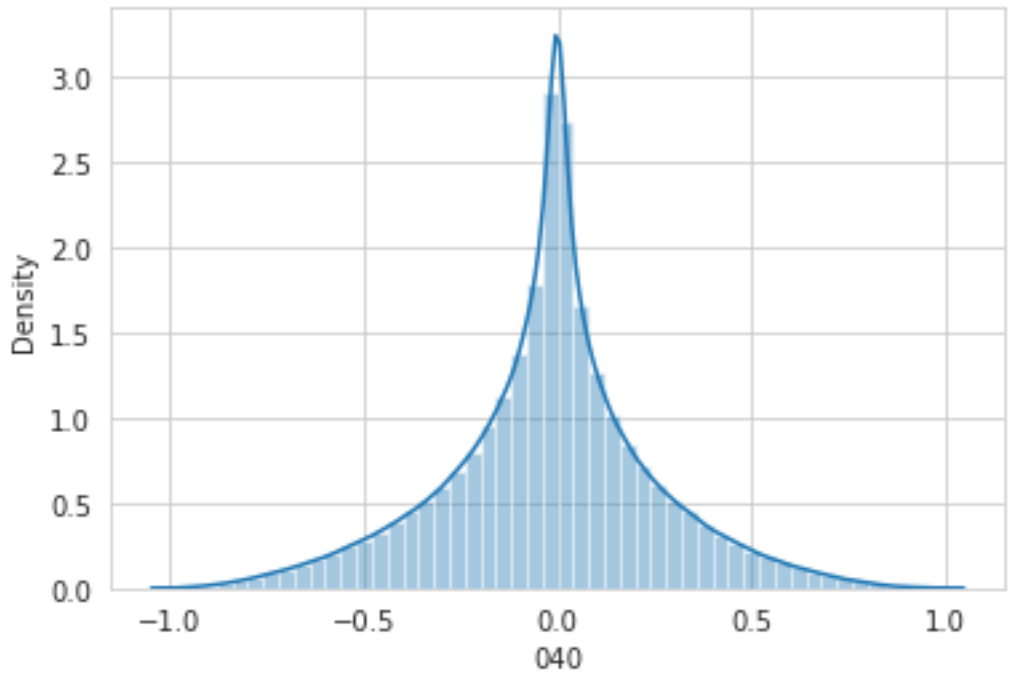
[349]:
```
alpha = 40
```

[350]:
```
%%time
alphas[f'{alpha:03}'] = alpha040(h, v)
```

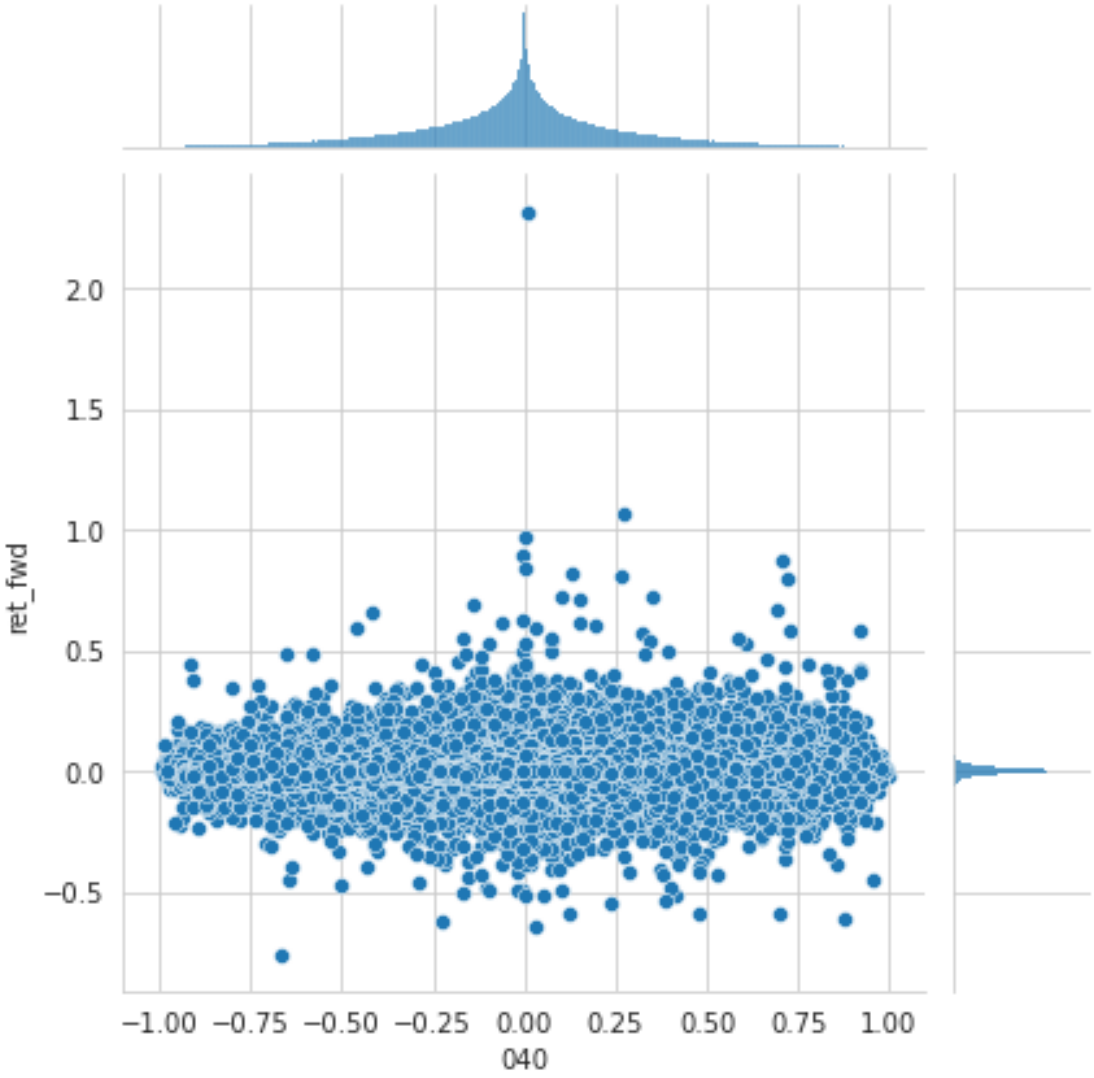
```
CPU times: user 3.71 s, sys: 15.9 ms, total: 3.72 s
Wall time: 3.68 s
```

[351]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[352]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[353]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[354]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[354]: 0.008389463848225809

1.45 Alpha 041

power(high * low, 0.5) - vwap

[355]:
```
def alpha041(h, l, vwap):
    """power(high * low, 0.5) - vwap"""
    return (power(h.mul(l), 0.5)
            .sub(vwap)
            .stack('ticker')
```

```
            .swaplevel())
```

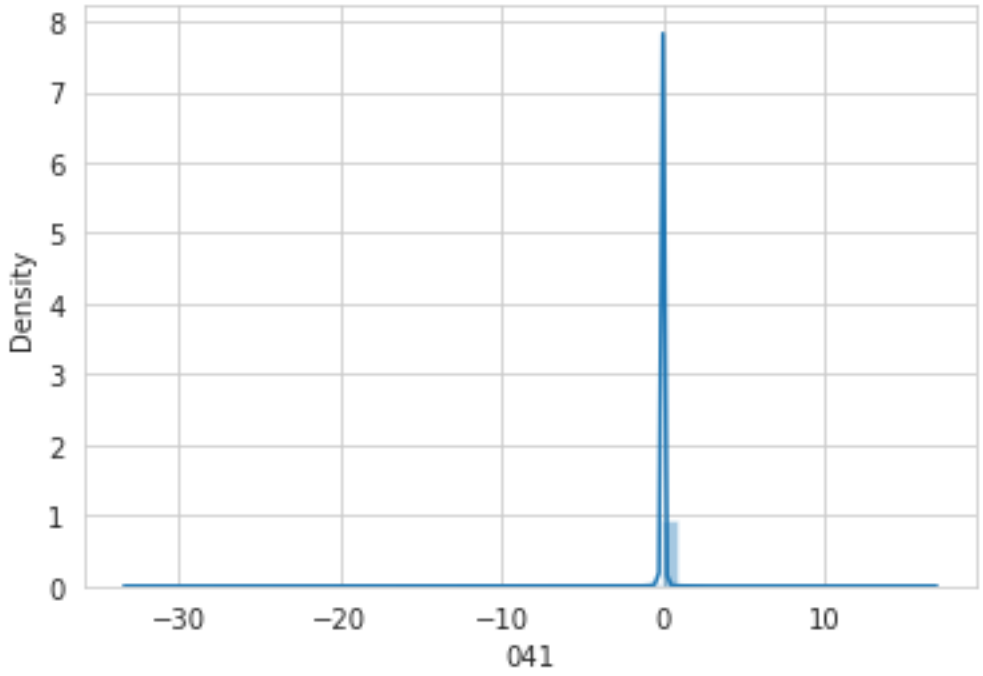
[356]:
```
alpha = 41
```

[357]:
```
%%time
alphas[f'{alpha:03}'] = alpha041(h, l, vwap)
```

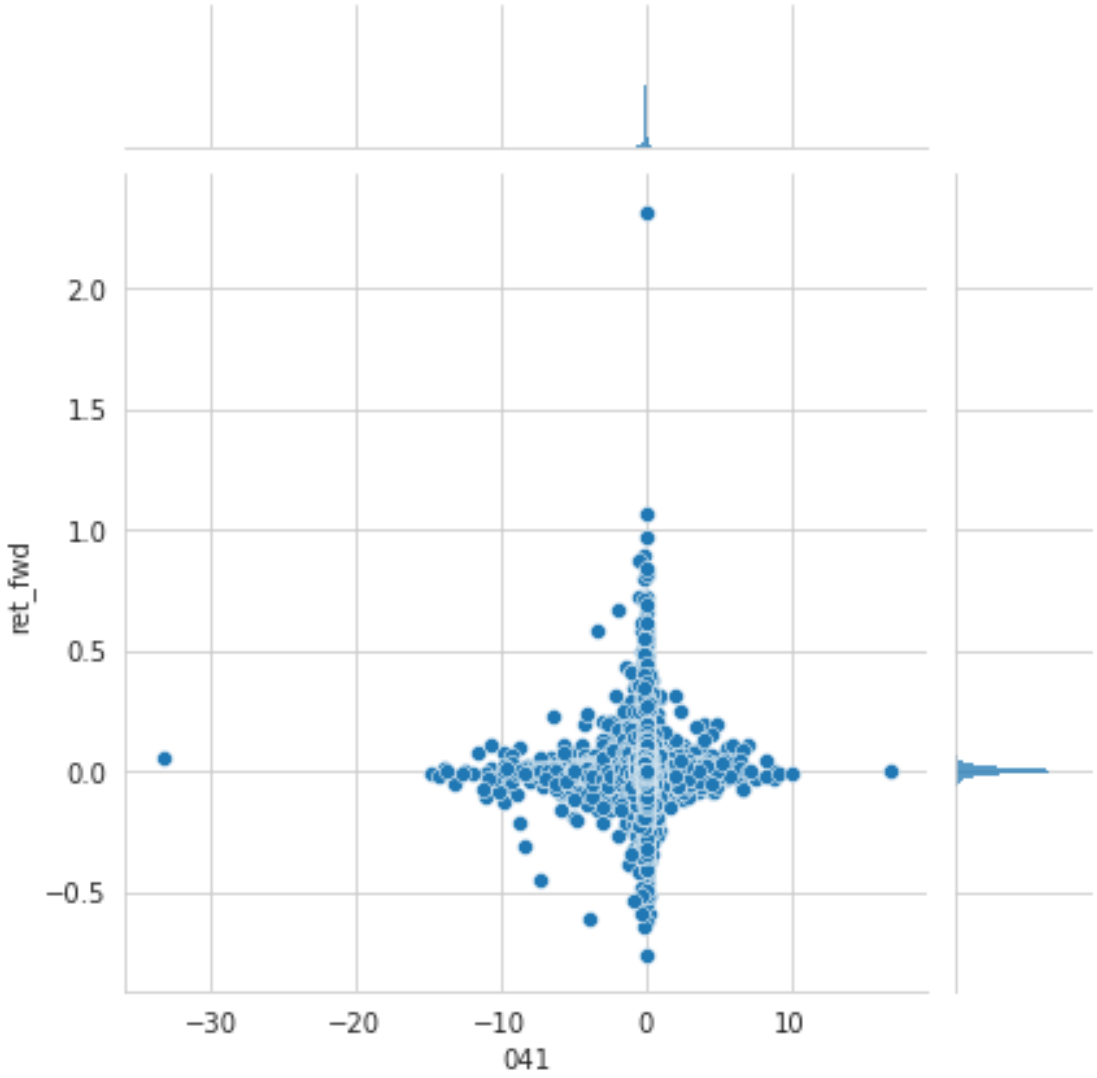
```
CPU times: user 2.32 s, sys: 16 ms, total: 2.34 s
Wall time: 2.3 s
```

[358]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[359]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[360]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[361]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[361]: 0.004631922179492598

1.46 Alpha 042

rank(vwap - close) / rank(vwap + close)

[362]:
```
def alpha042(c, vwap):
    """rank(vwap - close) / rank(vwap + close)"""
    return (rank(vwap.sub(c))
            .div(rank(vwap.add(c)))
            .stack('ticker')
```

```
            .swaplevel())
```

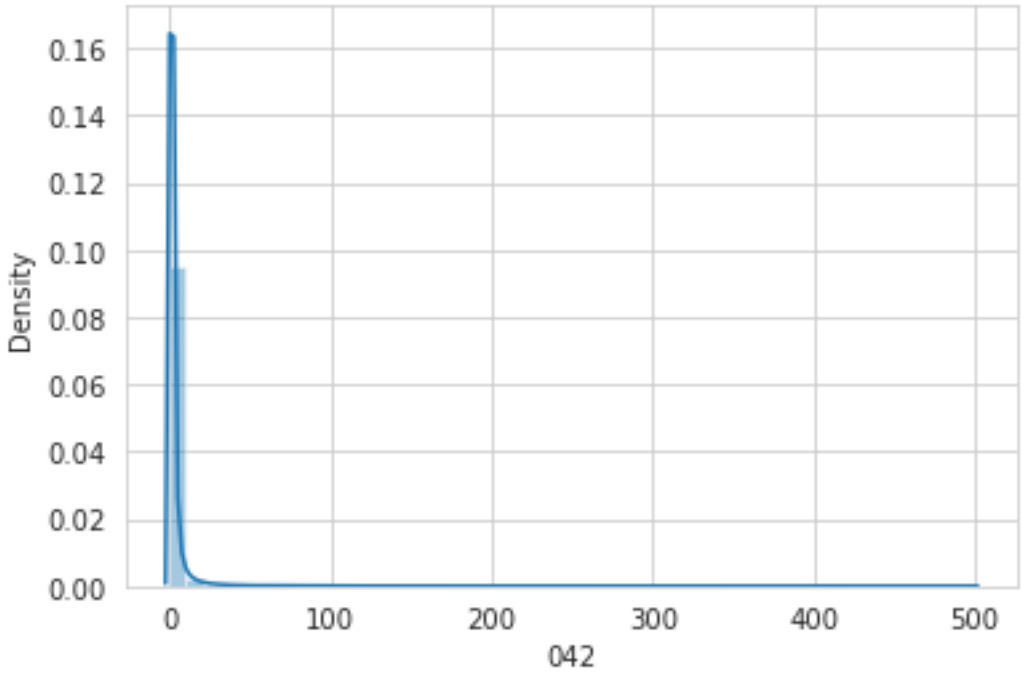
[363]:
```
alpha = 42
```

[364]:
```
%%time
alphas[f'{alpha:03}'] = alpha042(c, vwap)
```

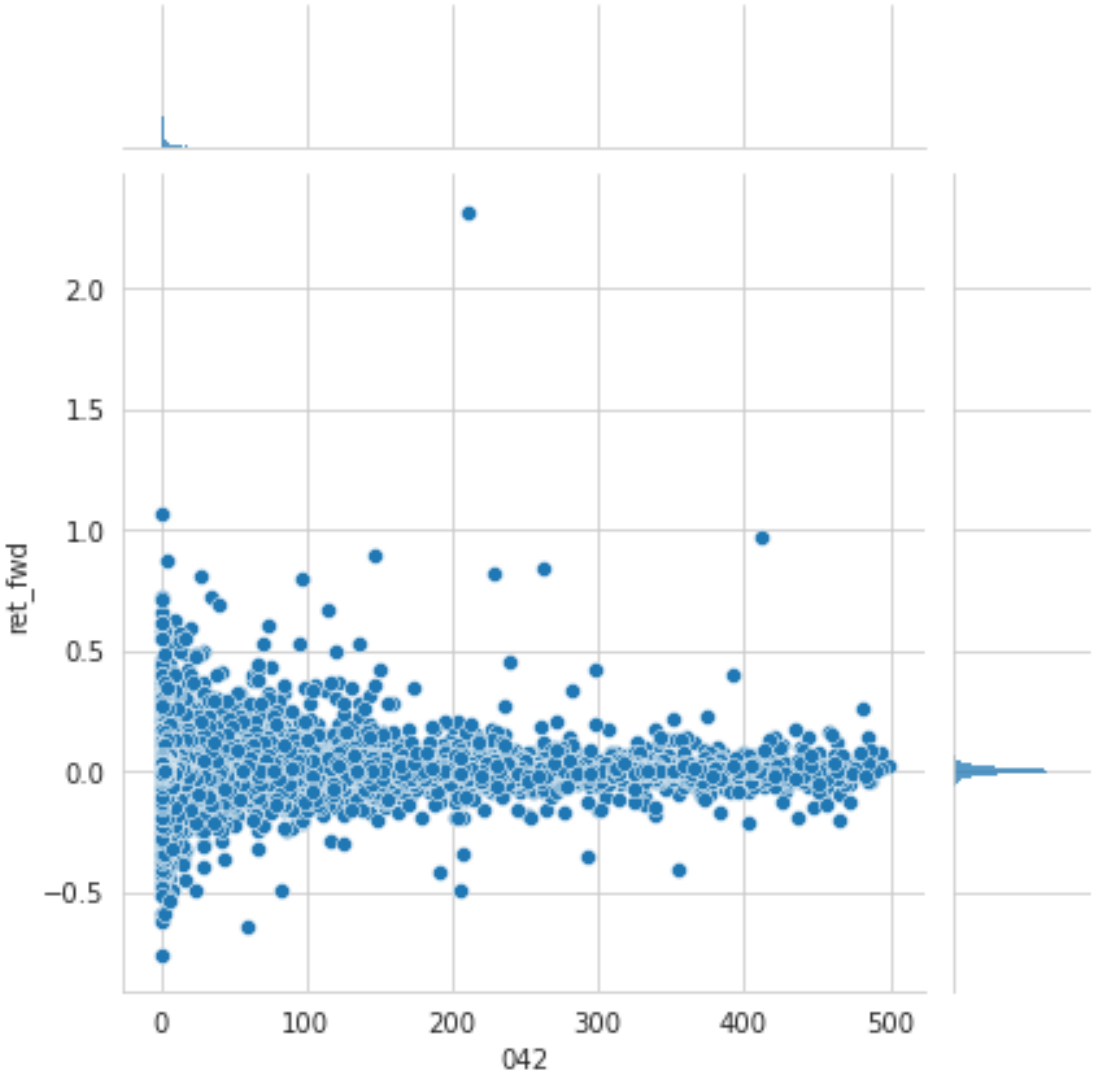
```
CPU times: user 2.43 s, sys: 36 ms, total: 2.46 s
Wall time: 2.43 s
```

[365]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[366]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[367]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[368]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[368]: 0.0003211794350050923

1.47 Alpha 043

```
((ts_sum(high, 20) / 20) < high)
           ? (-1 * ts_delta(high, 2))
           : 0
```

[369]:
```
def alpha043(c, adv20):
    """(ts_rank((volume / adv20), 20) * ts_rank((-1 * ts_delta(close, 7)),␣
 ↪8))"""
```

```
    return (ts_rank(v.div(adv20), 20)
            .mul(ts_rank(ts_delta(c, 7).mul(-1), 8))
            .stack('ticker')
            .swaplevel())
```

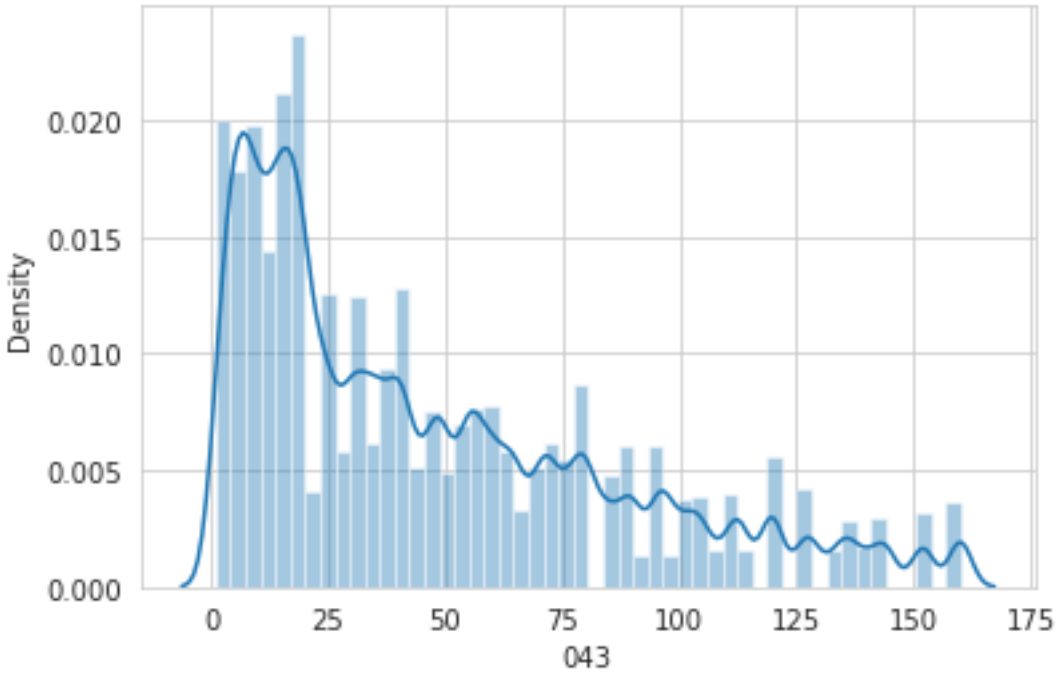
[370]:
```
alpha = 43
```

[371]:
```
%%time
alphas[f'{alpha:03}'] = alpha043(c, adv20)
```

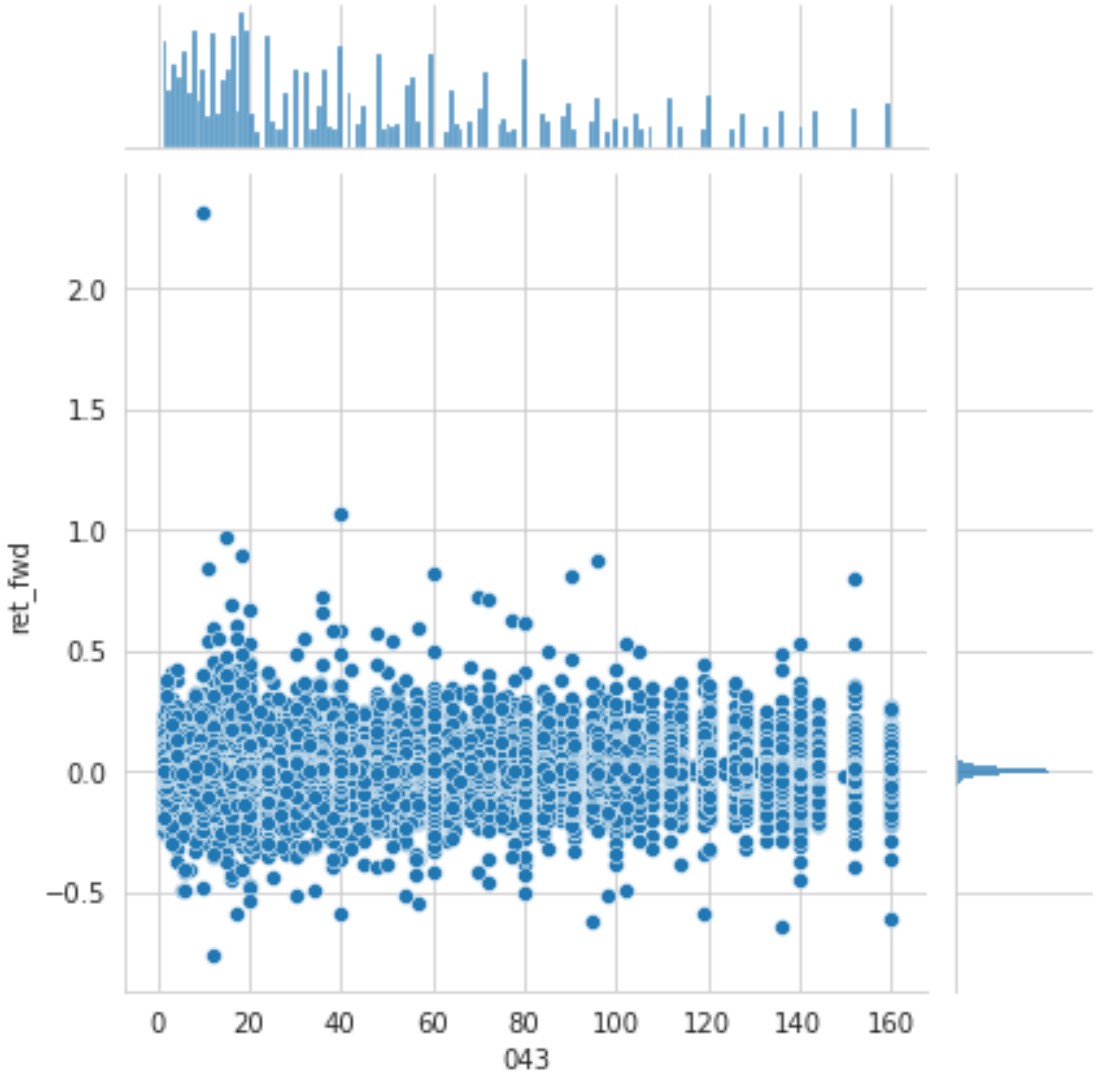
```
CPU times: user 6min 2s, sys: 72 ms, total: 6min 2s
Wall time: 6min 2s
```

[372]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[373]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[374]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[375]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[375]: 3.31646414482023e-05

1.48 Alpha 044

-ts_corr(high, rank(volume), 5)

[376]:
```
def alpha044(h, v):
    """-ts_corr(high, rank(volume), 5)"""

    return (ts_corr(h, rank(v), 5)
            .replace([-np.inf, np.inf], np.nan)
```

```
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

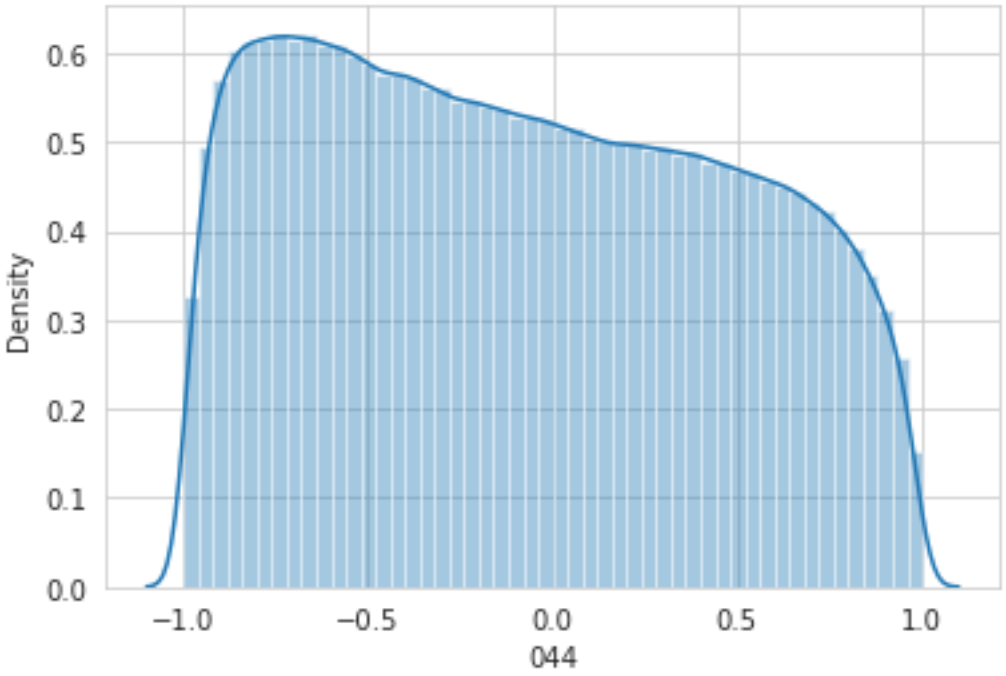
[377]:
```
alpha = 44
```

[378]:
```
%%time
alphas[f'{alpha:03}'] = alpha044(h, v)
```

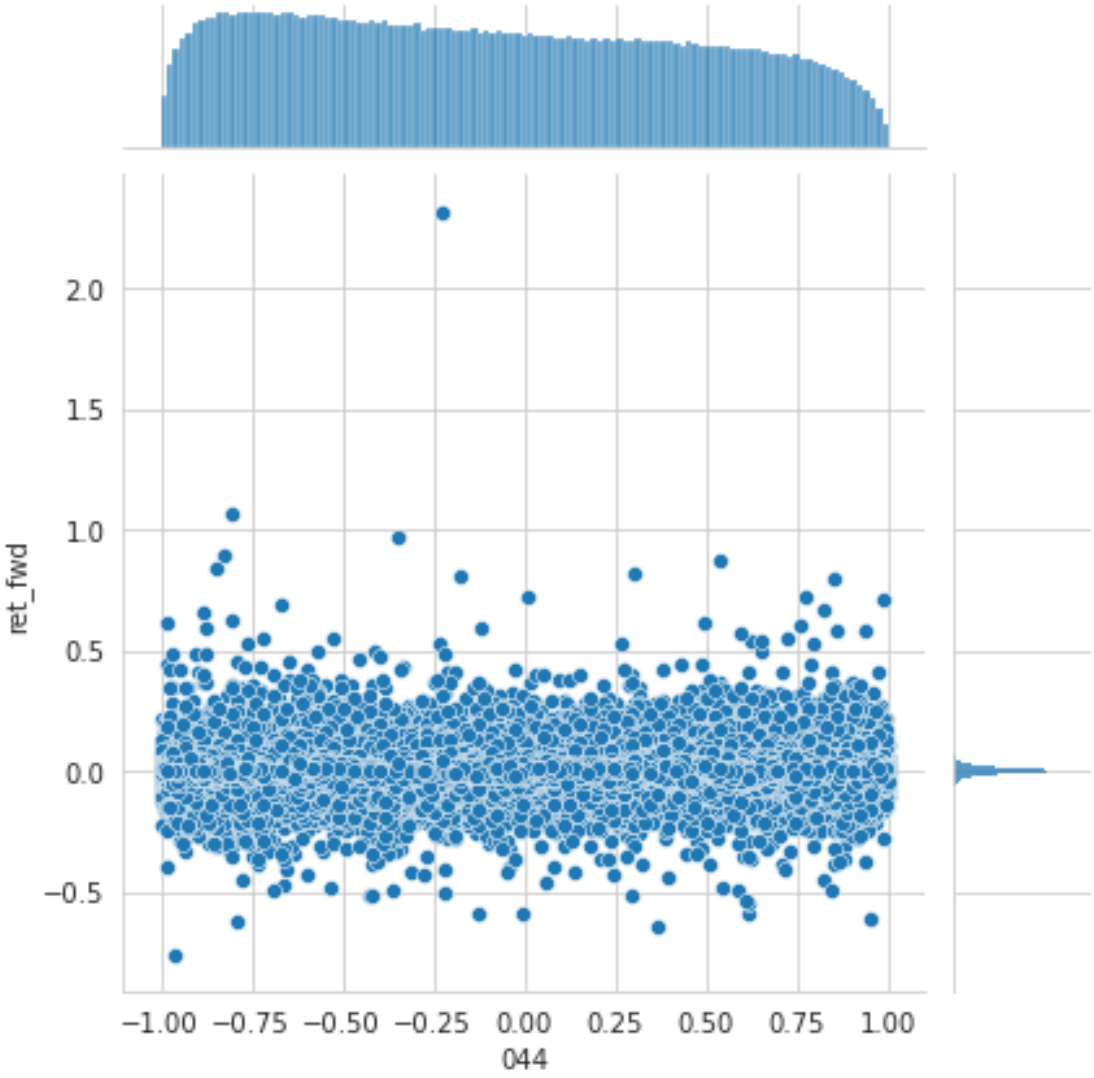
```
CPU times: user 3.69 s, sys: 28 ms, total: 3.72 s
Wall time: 3.69 s
```

[379]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[380]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[381]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[382]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[382]: 0

1.49 Alpha 045

```
-(rank((ts_mean(ts_lag(close, 5), 20)) *
       ts_corr(close, volume, 2)) *
       rank(ts_corr(ts_sum(close, 5), ts_sum(close, 20), 2)))
```

[383]:
```
def alpha045(c, v):
    """-(rank((ts_mean(ts_lag(close, 5), 20)) *
        ts_corr(close, volume, 2)) *
```

```
        rank(ts_corr(ts_sum(close, 5), ts_sum(close, 20), 2)))"""

    return (rank(ts_mean(ts_lag(c, 5), 20))
            .mul(ts_corr(c, v, 2)
                 .replace([-np.inf, np.inf], np.nan))
            .mul(rank(ts_corr(ts_sum(c, 5),
                              ts_sum(c, 20), 2)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

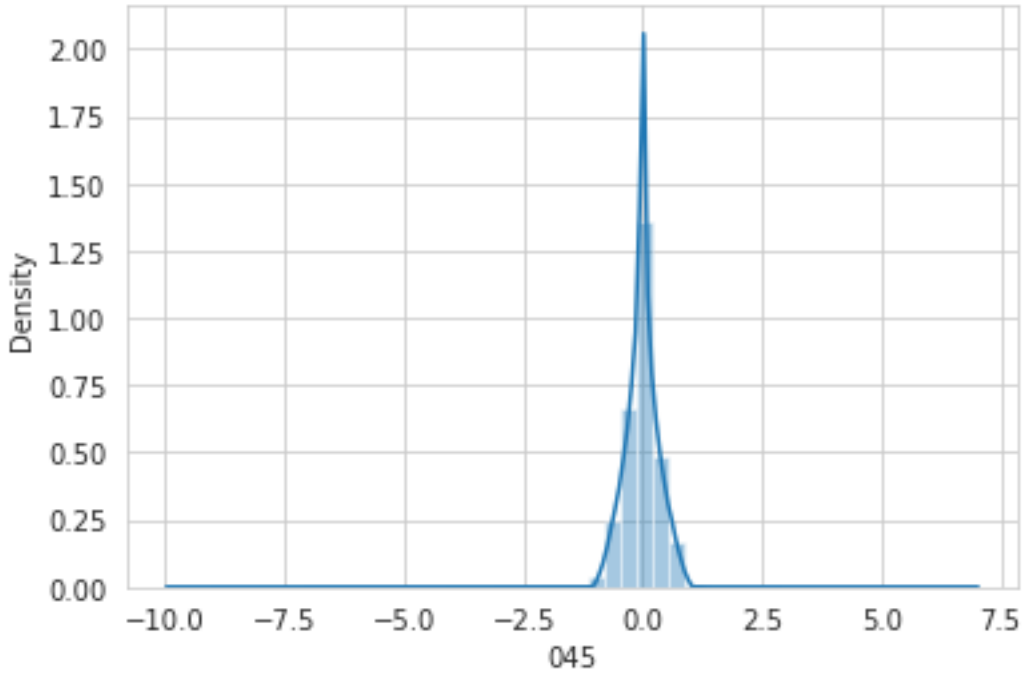
[384]:
```
alpha = 45
```

[385]:
```
%%time
alphas[f'{alpha:03}'] = alpha045(c, v)
```

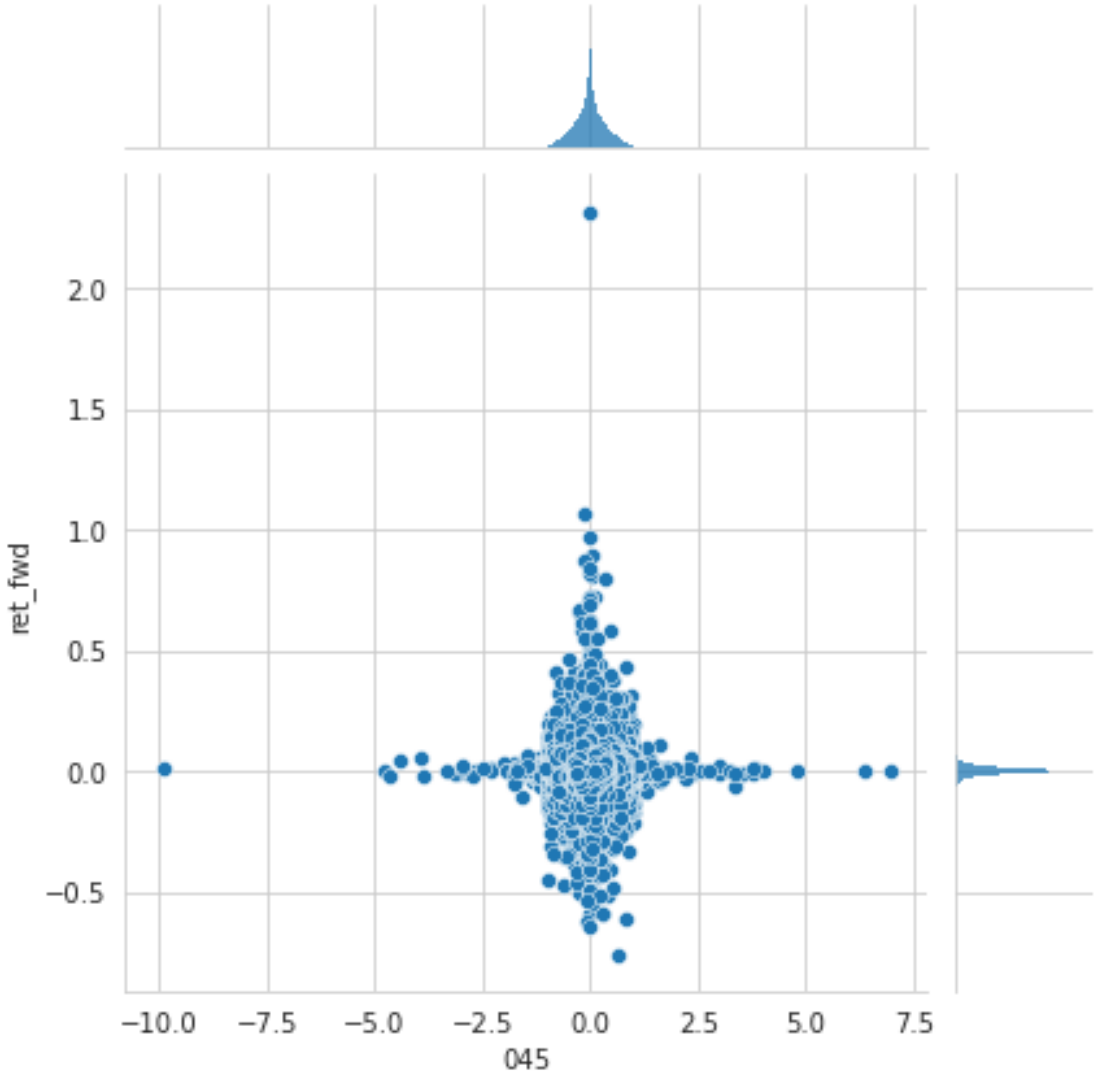
```
CPU times: user 5.26 s, sys: 76 ms, total: 5.33 s
Wall time: 5.18 s
```

[386]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[387]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[388]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[389]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[389]: 0.008224194668740914

1.50 Alpha 046

```
0.25 < ts_lag(ts_delta(close, 10), 10) / 10 - ts_delta(close, 10) / 10
    ? -1
    : ((ts_lag(ts_delta(close, 10), 10) / 10 - ts_delta(close, 10) / 10 < 0)
        ? 1
        : -ts_delta(close, 1))
```

[390]:
```
def alpha046(c):
    """0.25 < ts_lag(ts_delta(close, 10), 10) / 10 - ts_delta(close, 10) / 10
            ? -1
            : ((ts_lag(ts_delta(close, 10), 10) / 10 - ts_delta(close, 10) / 10␣
 ↪< 0)
                ? 1
                : -ts_delta(close, 1))
    """

    cond = ts_lag(ts_delta(c, 10), 10).div(10).sub(ts_delta(c, 10).div(10))
    alpha = pd.DataFrame(-np.ones_like(cond),
                         index=c.index,
                         columns=c.columns)
    alpha[cond.isnull()] = np.nan
    return (cond.where(cond > 0.25,
                       -alpha.where(cond < 0,
                       -ts_delta(c, 1)))
            .stack('ticker')
            .swaplevel())
```

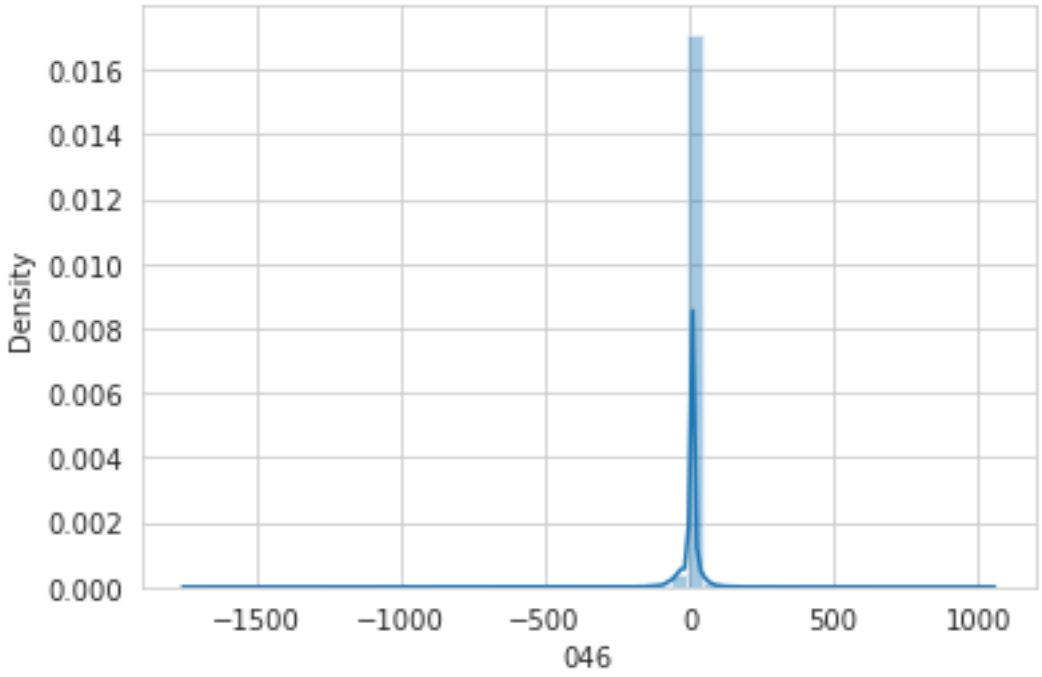
[391]:
```
alpha = 46
```

[392]:
```
%%time
alphas[f'{alpha:03}'] = alpha046(c)
```

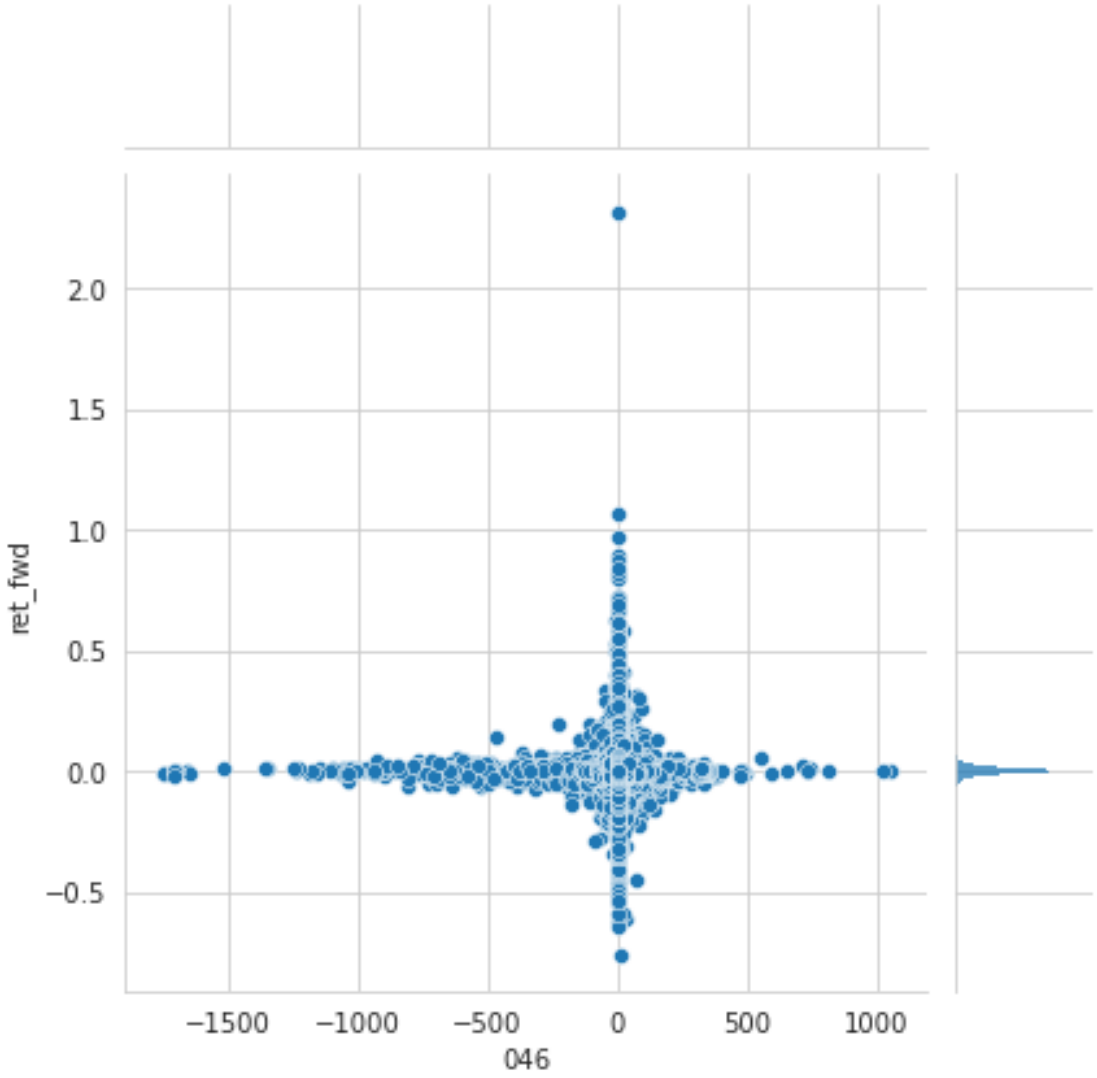
```
CPU times: user 2.37 s, sys: 12 ms, total: 2.38 s
Wall time: 2.34 s
```

[393]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[394]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[395]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[396]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[396]: 0.00870732283747122

1.51 Alpha 047

```
rank(ts_corr(ts_lag(open - close, 1), close, 200)) +
       rank(open - close)
```

[397]:
```
def alpha047(h, c, v, vwap, adv20):
    """((((rank((1 / close)) * volume) / adv20) * ((high * rank((high -␣
↪close))) /
       (ts_sum(high, 5) /5))) - rank((vwap - ts_lag(vwap, 5))))"""
```

```
    return (rank(c.pow(-1)).mul(v).div(adv20)
            .mul(h.mul(rank(h.sub(c))
                       .div(ts_mean(h, 5)))
                 .sub(rank(ts_delta(vwap, 5))))
            .stack('ticker')
            .swaplevel())
```

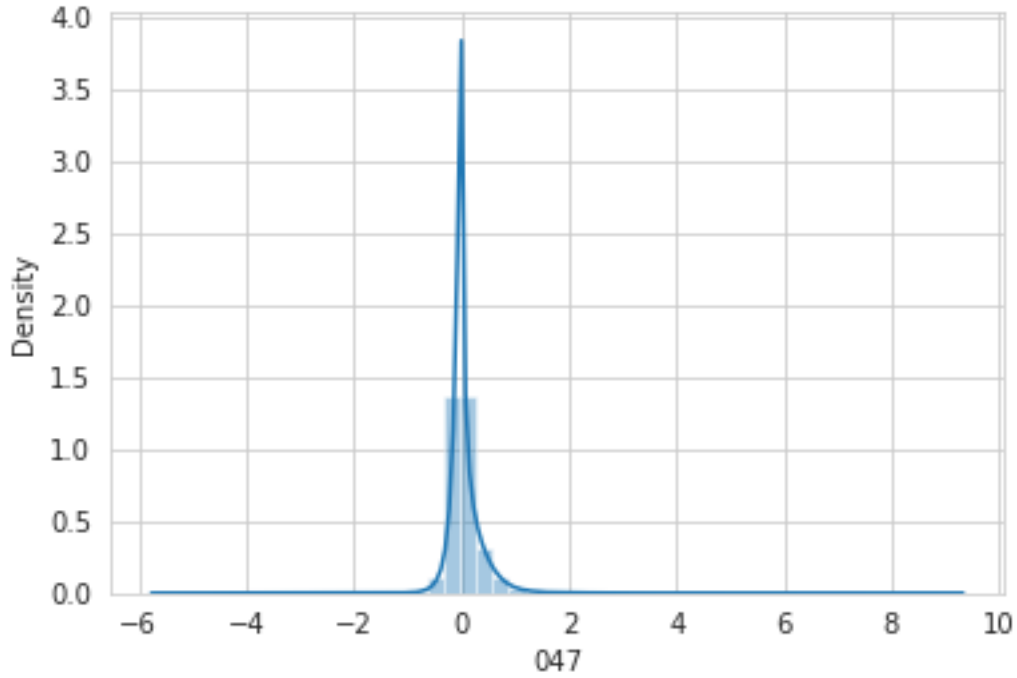
[398]:
```
alpha = 47
```

[399]:
```
%%time
alphas[f'{alpha:03}'] = alpha047(h, c, v, vwap, adv20)
```

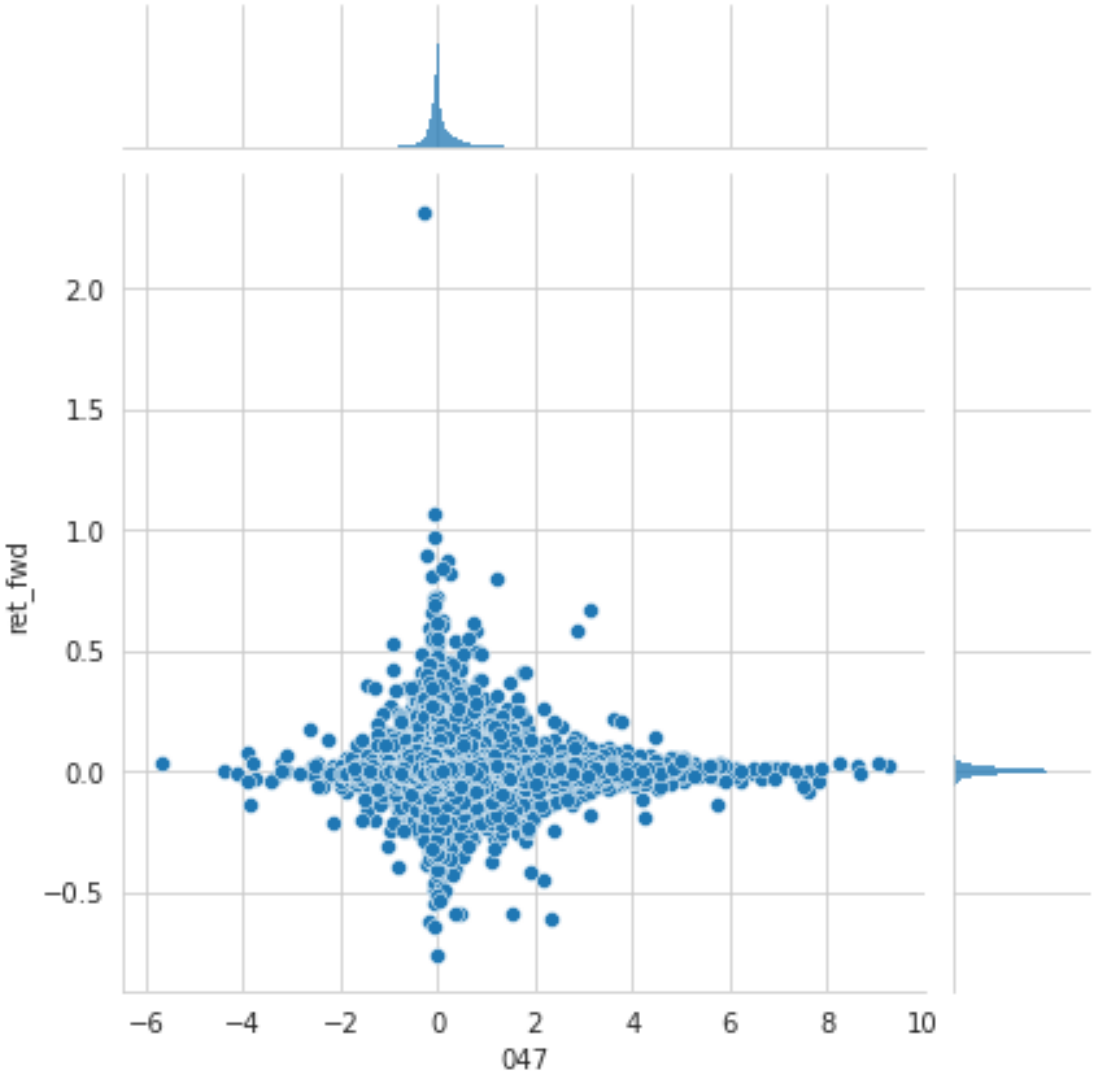
```
CPU times: user 2.87 s, sys: 64.1 ms, total: 2.93 s
Wall time: 2.81 s
```

[400]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[401]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[402]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[403]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[403]: 0.0009995443357944112

1.52 Alpha 048

(indneutralize(((ts_corr(ts_delta(close, 1), ts_delta(ts_lag(close, 1), 1), 250) *ts_delta(clos

[404]:
```
def alpha48(c, industry):
    """(indneutralize(((ts_corr(ts_delta(close, 1), ts_delta(ts_lag(close, 1),␣
↪1), 250) *
        ts_delta(close, 1)) / close), IndClass.subindustry) /
        ts_sum(((ts_delta(close, 1) / ts_lag(close, 1))^2), 250))"""
```

```
    pass
```

[405]:
```
alpha = 48
```

[406]:
```
# %%time
# alphas[f'{alpha:03}'] = alpha48(o, c)
```

[407]:
```
# alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[408]:
```
# sns.distplot(alphas[f'{alpha:03}']);
```

[409]:
```
# g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
#
```

[410]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.53 Alpha 049

```
ts_delta(ts_lag(close, 10), 10).div(10).sub(ts_delta(close, 10).div(10)) < -0.1 * c
        ? 1
        : -ts_delta(close, 1)
```

[411]:
```
def alpha049(c):
    """ts_delta(ts_lag(close, 10), 10).div(10).sub(ts_delta(close, 10).div(10))␣
↪< -0.1 * c
        ? 1
        : -ts_delta(close, 1)"""
    cond = (ts_delta(ts_lag(c, 10), 10).div(10)
            .sub(ts_delta(c, 10).div(10)) >= -0.1 * c)
    return (-ts_delta(c, 1)
            .where(cond, 1)
            .stack('ticker')
            .swaplevel())
```

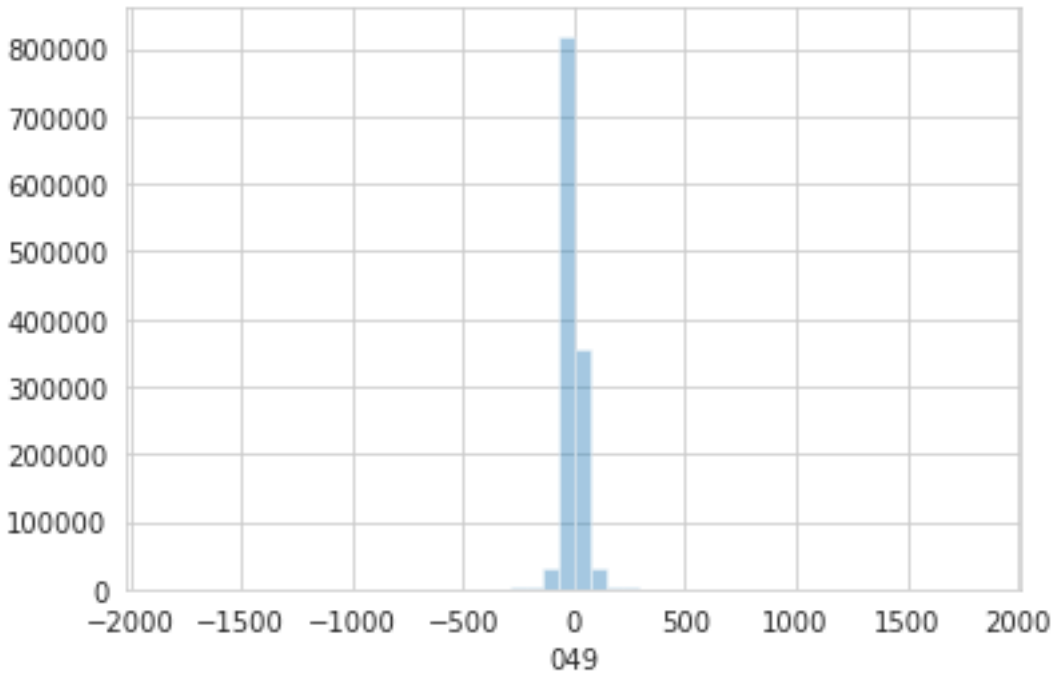
[412]:
```
alpha = 49
```

[413]:
```
%%time
alphas[f'{alpha:03}'] = alpha049(c)
```

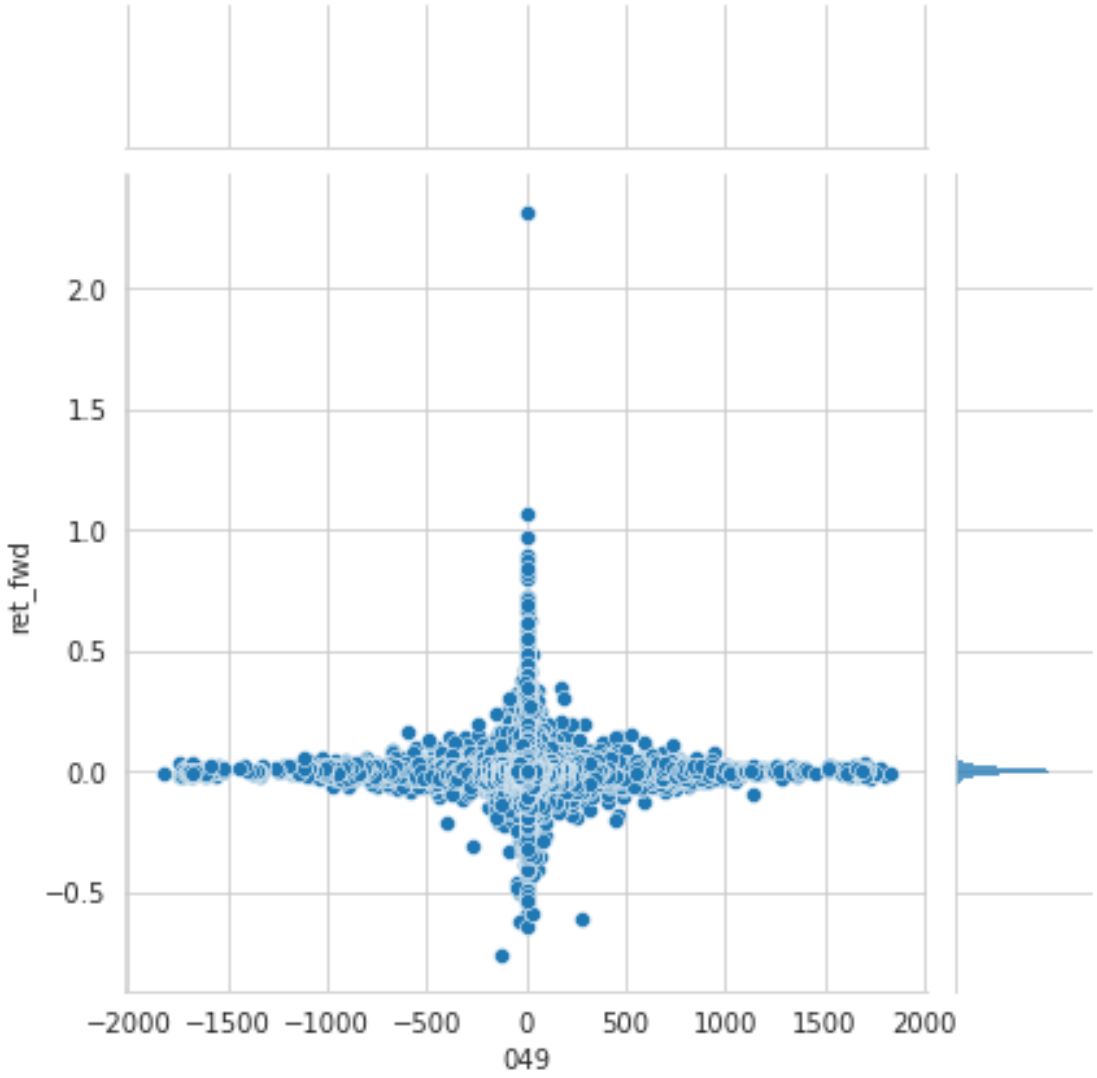
```
CPU times: user 3.13 s, sys: 32 ms, total: 3.16 s
Wall time: 3.12 s
```

[414]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[415]:
```
sns.distplot(alphas[f'{alpha:03}'], kde=False);
```



[416]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.54 Alpha 050

-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)

[417]:
```
def alpha050(v, vwap):
    """-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)"""
    return (ts_max(rank(ts_corr(rank(v),
                                rank(vwap), 5)), 5)
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

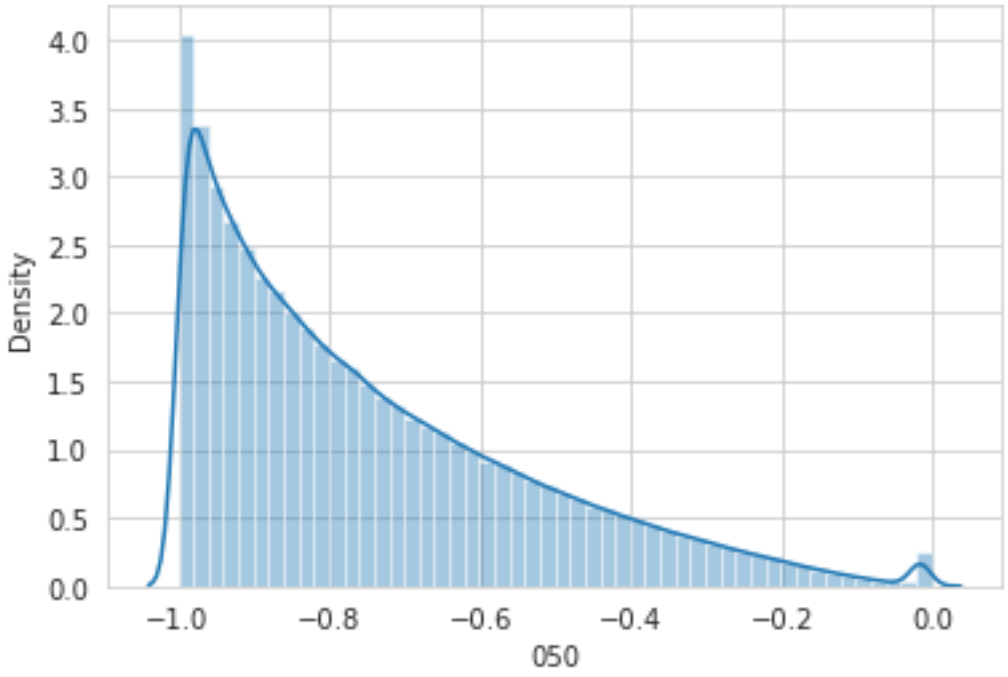
[418]:
```
alpha = 50
```

[419]:
```
%%time
alphas[f'{alpha:03}'] = alpha050(v, vwap)
```

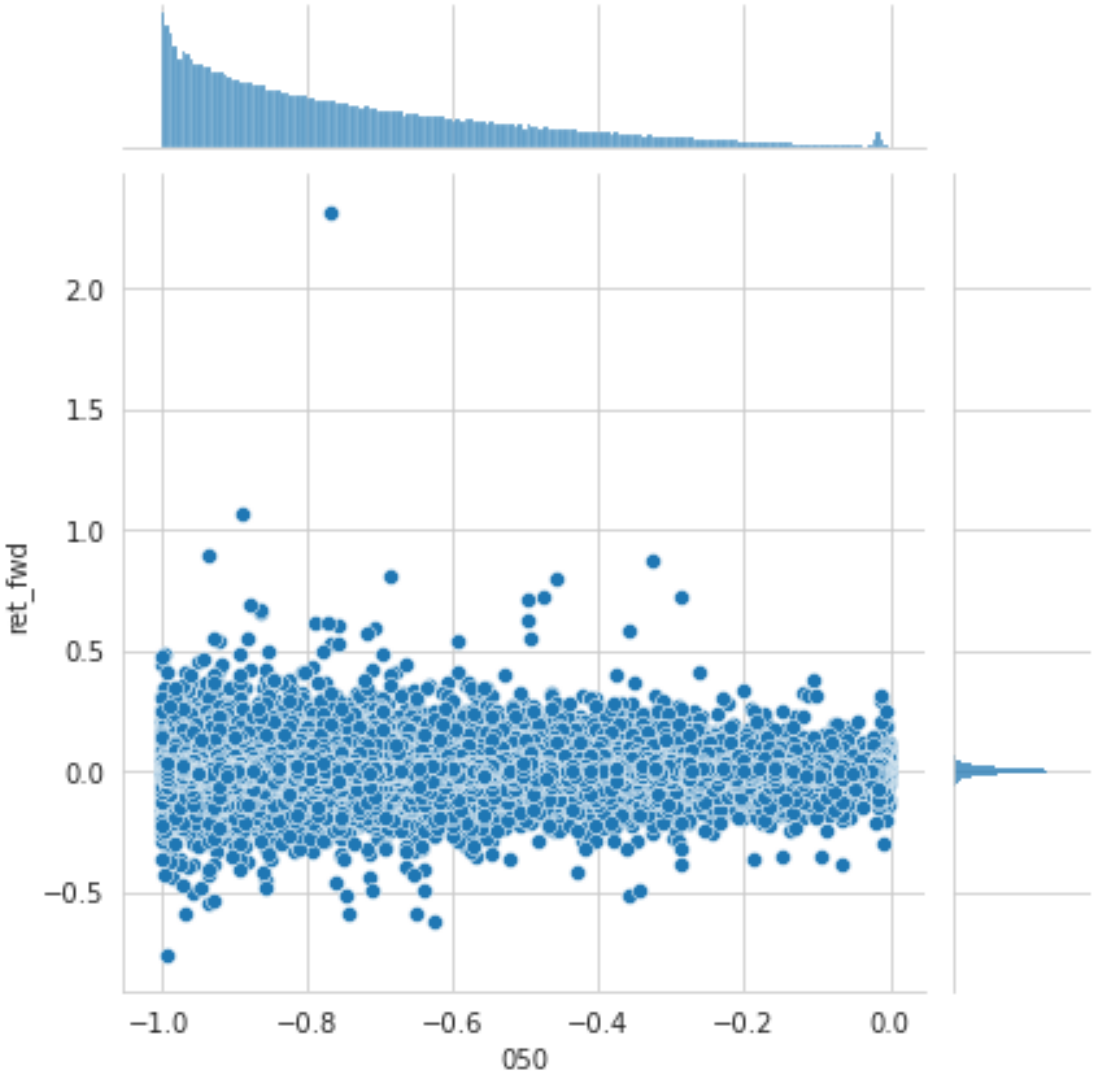
```
CPU times: user 2.98 s, sys: 88 ms, total: 3.07 s
Wall time: 3.01 s
```

[420]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[421]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[422]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[423]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[423]: 0

1.55 Alpha 051

```
ts_delta(ts_lag(close, 10), 10).div(10).sub(ts_delta(close, 10).div(10)) < -0.05 * c
        ? 1
        : -ts_delta(close, 1)
```

[424]:
```
def alpha051(c):
    """ts_delta(ts_lag(close, 10), 10).div(10).sub(ts_delta(close, 10).div(10))␣
 ↪< -0.05 * c
```

```
        ? 1
        : -ts_delta(close, 1)"""
    cond = (ts_delta(ts_lag(c, 10), 10).div(10)
            .sub(ts_delta(c, 10).div(10)) >= -0.05 * c)
    return (-ts_delta(c, 1)
            .where(cond, 1)
            .stack('ticker')
            .swaplevel())
```

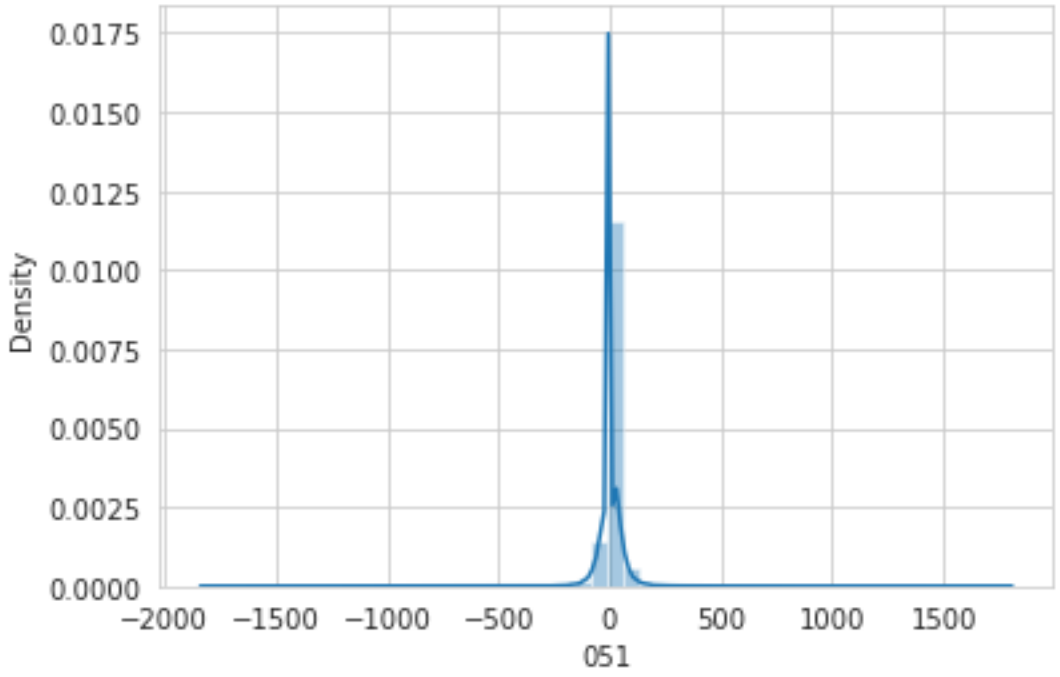
[425]:
```
alpha = 51
```

[426]:
```
%%time
alphas[f'{alpha:03}'] = alpha051(c)
```

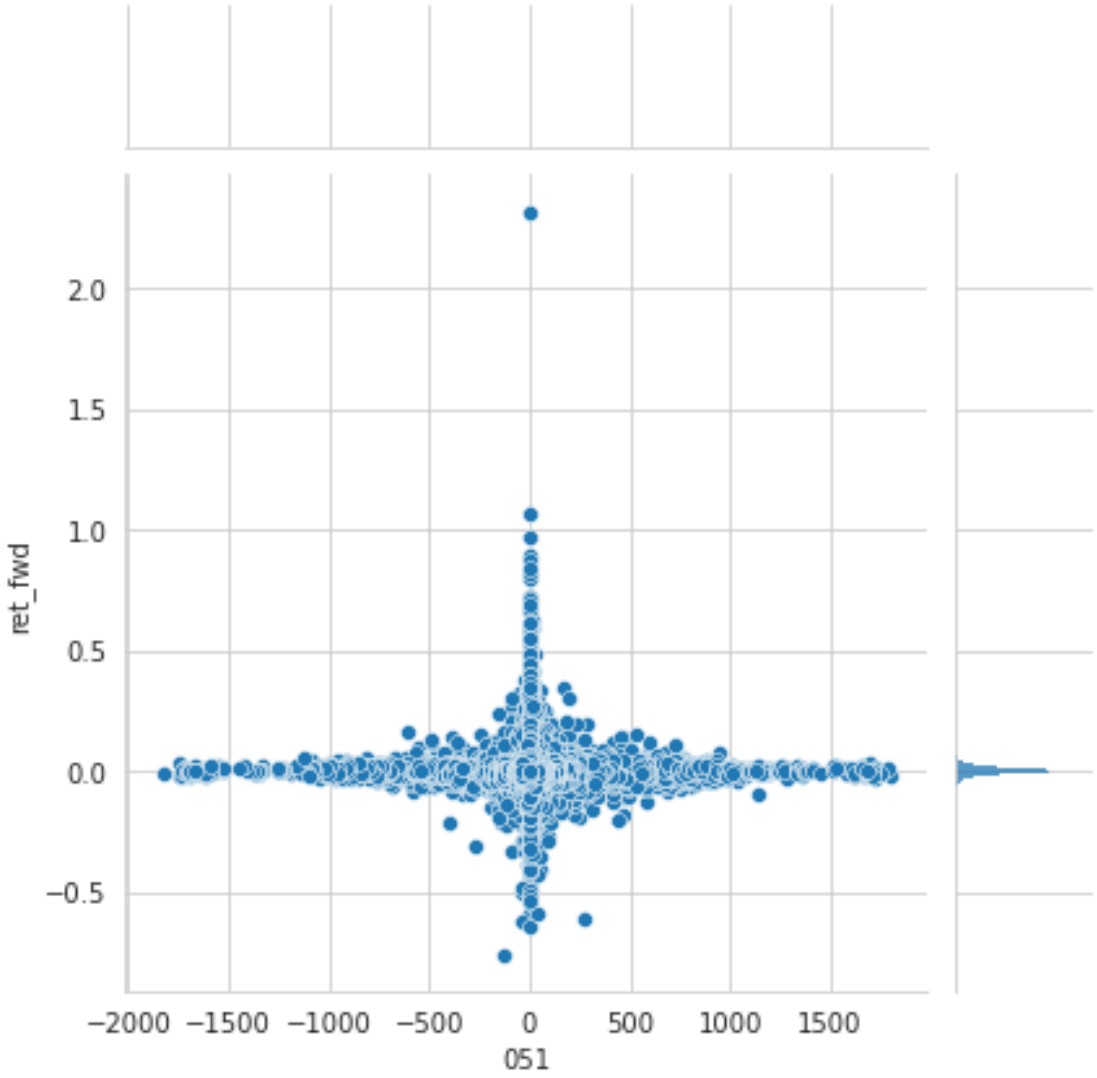
```
CPU times: user 5.92 s, sys: 128 ms, total: 6.05 s
Wall time: 6 s
```

[427]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[428]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[429]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[430]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[430]: 0.010624389695808034

1.56 Alpha 052

```
(ts_lag(ts_min(low, 5), 5) - ts_min(low, 5)) *
        rank((ts_sum(returns, 240) - ts_sum(returns, 20)) / 220) *
        ts_rank(volume, 5)
```

[431]:
```
def alpha052(l, v, r):
    """(ts_lag(ts_min(low, 5), 5) - ts_min(low, 5)) *
        rank((ts_sum(returns, 240) - ts_sum(returns, 20)) / 220) *
```

```
        ts_rank(volume, 5)
    """
    return (ts_delta(ts_min(l, 5), 5)
            .mul(rank(ts_sum(r, 240)
                      .sub(ts_sum(r, 20))
                      .div(220)))
            .mul(ts_rank(v, 5))
            .stack('ticker')
            .swaplevel())
```

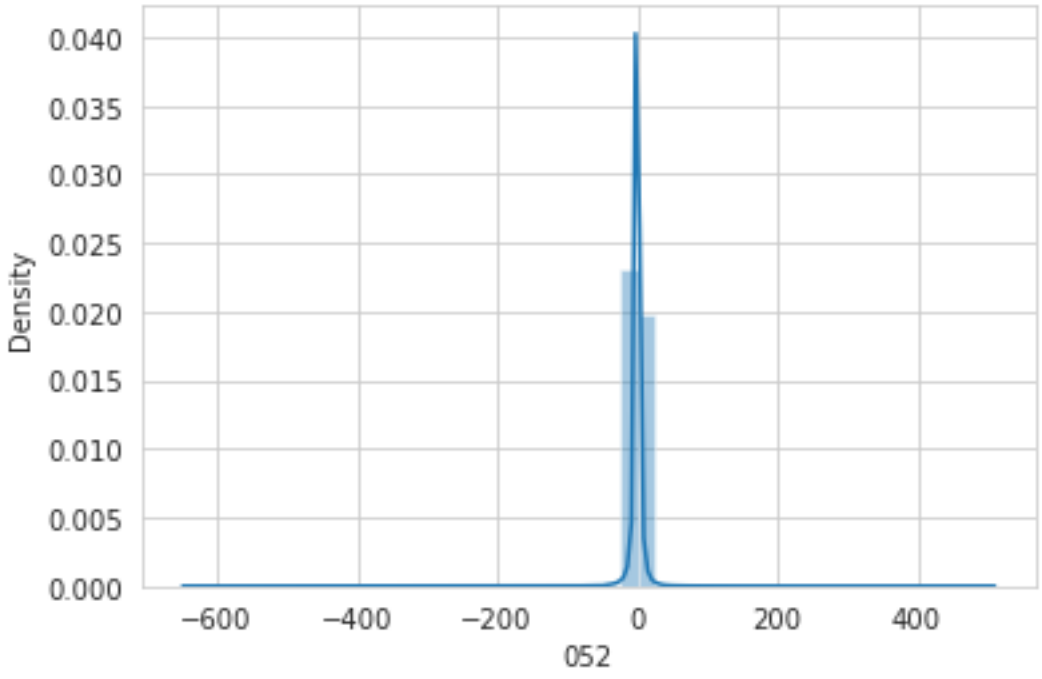
[432]:
```
alpha = 52
```

[433]:
```
%%time
alphas[f'{alpha:03}'] = alpha052(l, v, r)
```

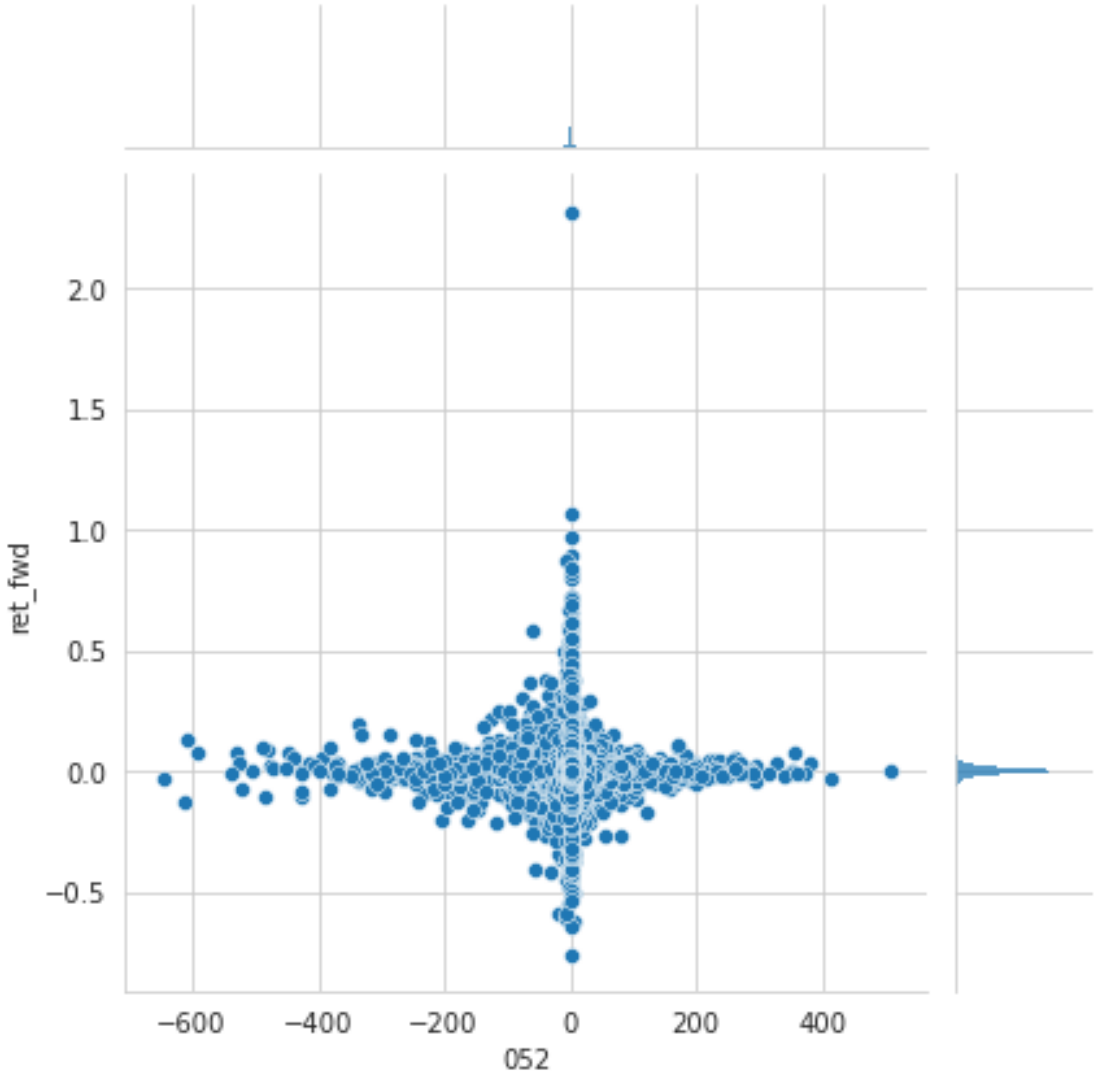
```
CPU times: user 3min 4s, sys: 52 ms, total: 3min 4s
Wall time: 3min 4s
```

[434]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[435]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[436]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[437]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[437]: 0.007025458925477679

1.57 Alpha 053

```
((ts_sum(high, 20) / 20) < high)
           ? (-1 * ts_delta(high, 2))
           : 0
```

[438]:
```
def alpha053(h, l, c):
    """-1 * ts_delta(1 - (high - close) / (close - low), 9)"""
    inner = (c.sub(l)).add(1e-6)
```

```
    return (ts_delta(h.sub(c)
                     .mul(-1).add(1)
                     .div(c.sub(1)
                          .add(1e-6)), 9)
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

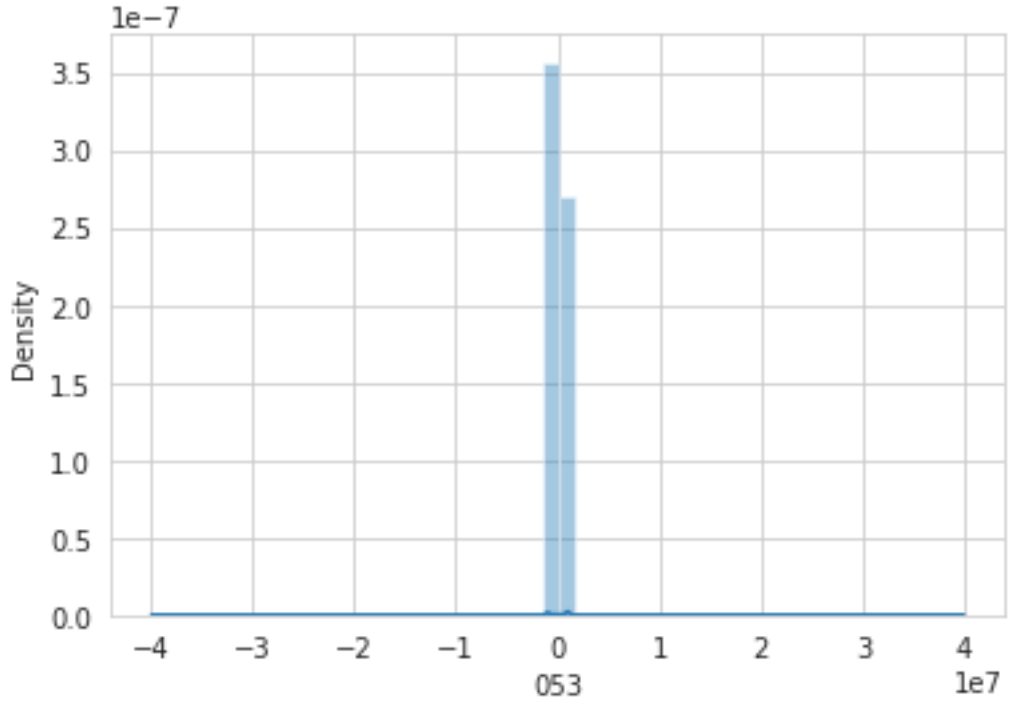
[439]:
```
alpha = 53
```

[440]:
```
%%time
alphas[f'{alpha:03}'] = alpha053(h, l, c)
```

```
CPU times: user 1.51 s, sys: 0 ns, total: 1.51 s
Wall time: 1.45 s
```

[441]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[442]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[ ]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```

[ ]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.58 Alpha 054

-(low - close) * power(open, 5) / ((low - high) * power(close, 5))

[35]:
```
def alpha054(o, h, l, c):
    """-(low - close) * power(open, 5) / ((low - high) * power(close, 5))"""
    return (l.sub(c).mul(o.pow(5)).mul(-1)
            .div(l.sub(h).replace(0, -0.0001).mul(c ** 5))
            .stack('ticker')
            .swaplevel())
```

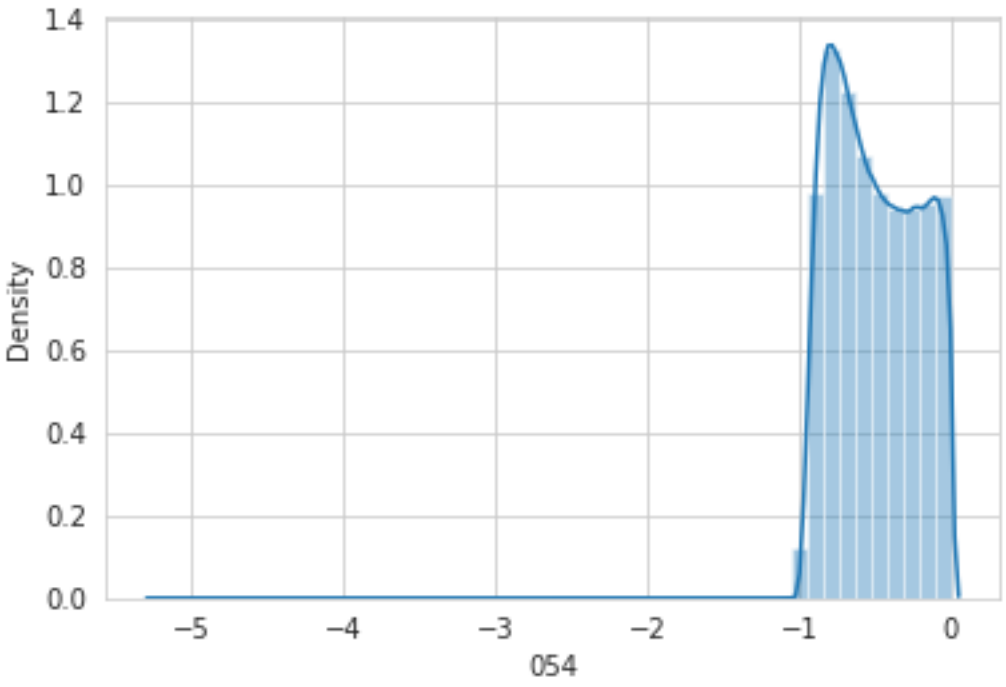
[36]:
```
alpha = 54
```

[37]:
```
%%time
alphas[f'{alpha:03}'] = alpha054(o, h, l, c)
```

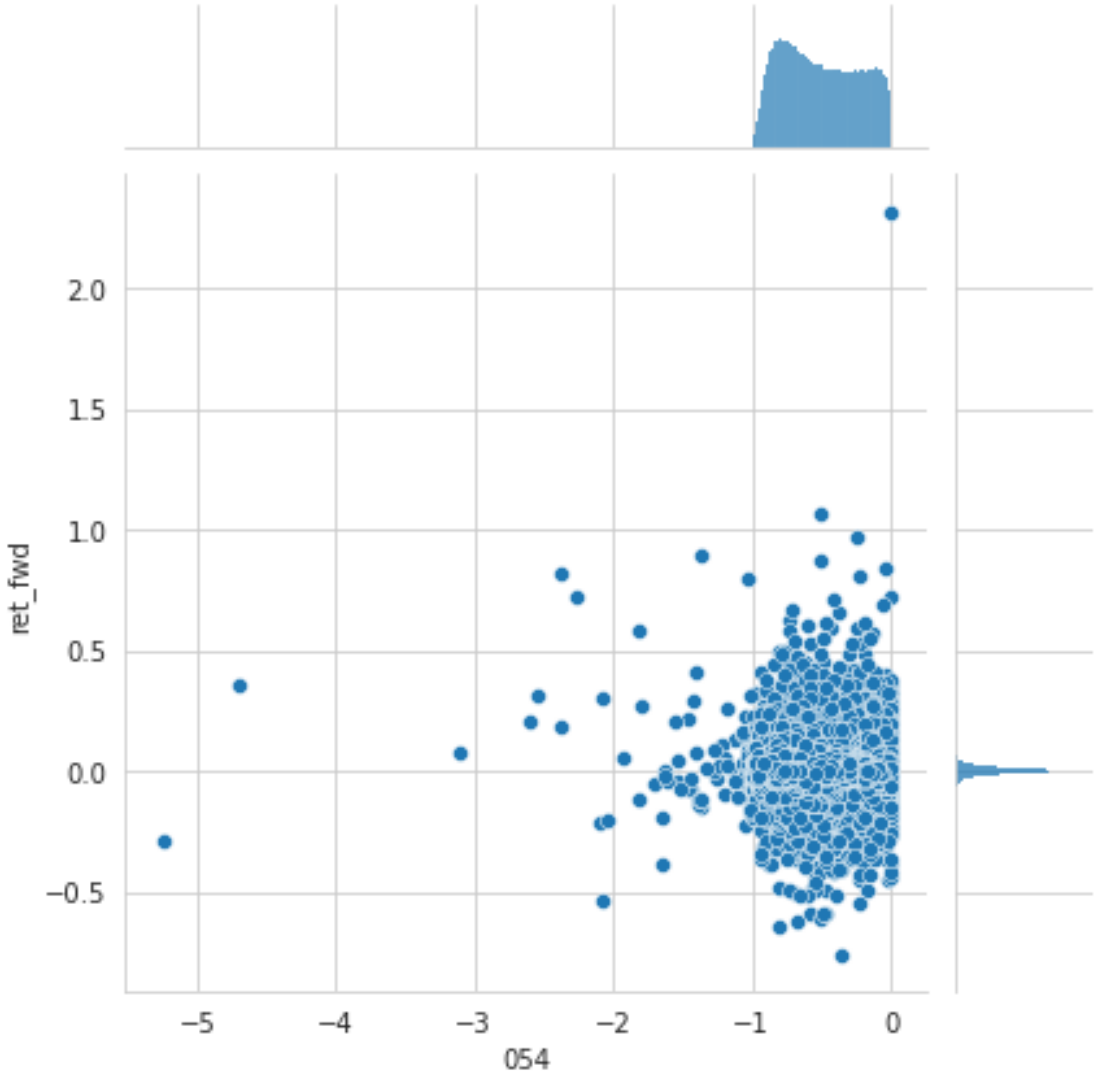
```
CPU times: user 1.99 s, sys: 42.8 ms, total: 2.03 s
Wall time: 1.91 s
```

[38]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[39]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[40]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[41]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[41]:
```
0.0007175455210228776
```

[42]:
```
pd.Series(mi).tail()
```

[42]:
```
54    0.000718
dtype: float64
```

1.59 Alpha 055

```
(-1 * ts_corr(rank(((close - ts_min(low, 12)) /
                    (ts_max(high, 12) - ts_min(low,12)))),
```

```
                        rank(volume), 6))
```

[43]:
```
def alpha055(h, l, c):
    """(-1 * ts_corr(rank(((close - ts_min(low, 12)) /
                           (ts_max(high, 12) - ts_min(low,12)))),
                    rank(volume), 6))"""

    return (ts_corr(rank(c.sub(ts_min(l, 12))
                         .div(ts_max(h, 12).sub(ts_min(l, 12))
                              .replace(0, 1e-6))),
                    rank(v), 6)
            .replace([-np.inf, np.inf], np.nan)
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

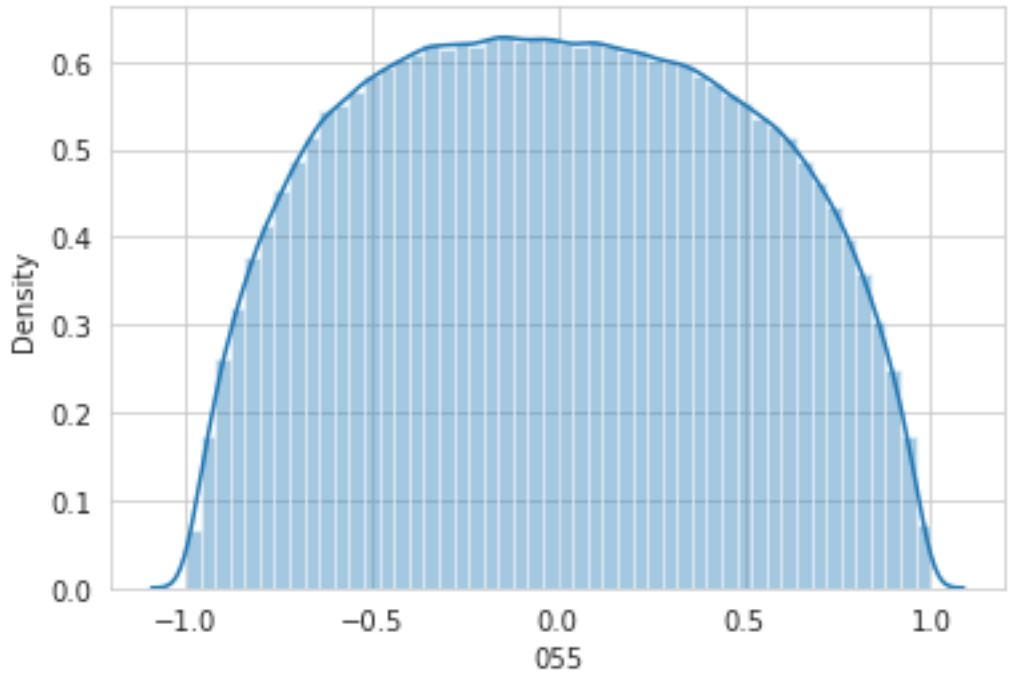
[44]:
```
alpha = 55
```

[45]:
```
%%time
alphas[f'{alpha:03}'] = alpha055(h, l, c)
```

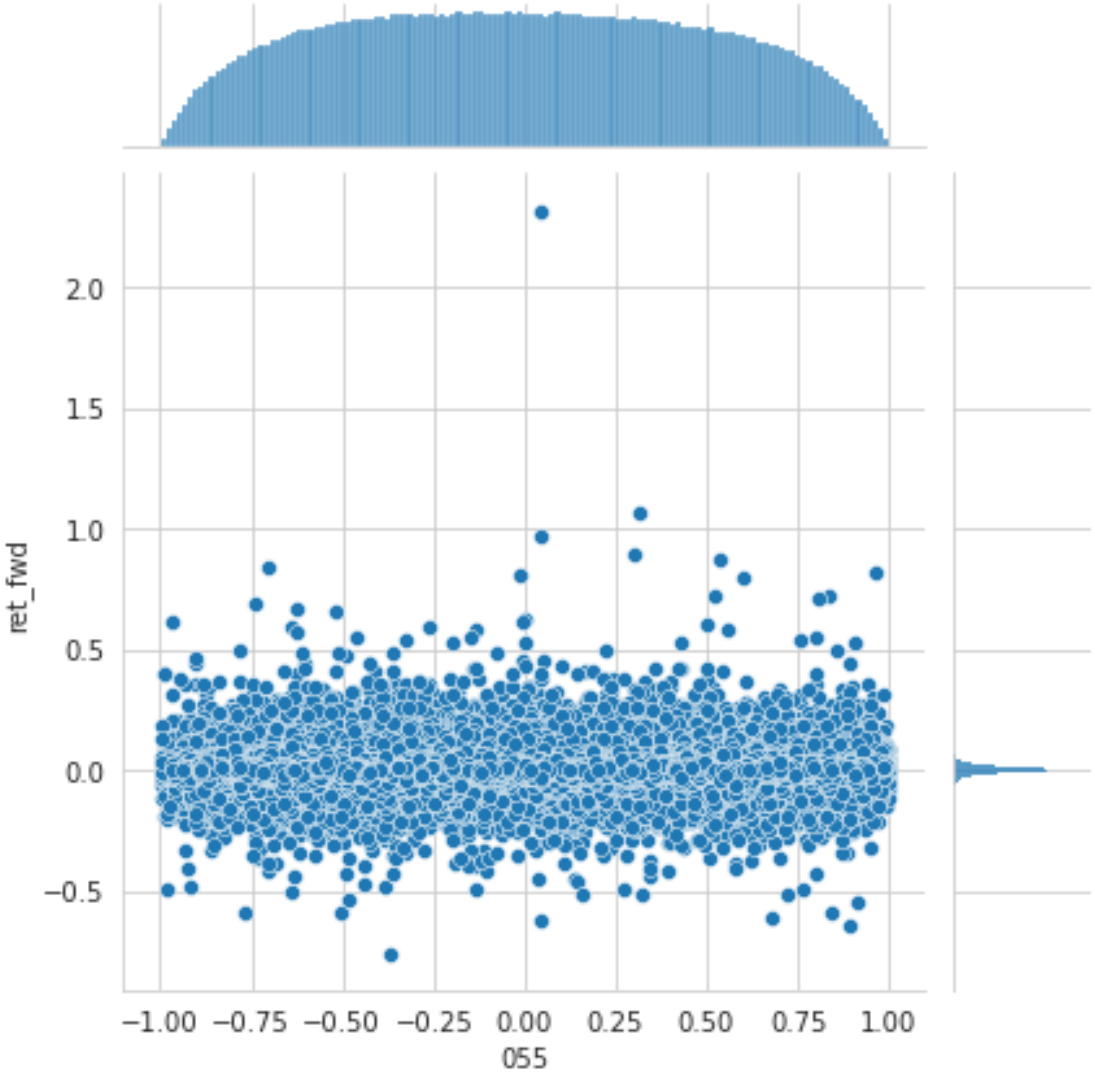
```
CPU times: user 3.83 s, sys: 65.4 ms, total: 3.89 s
Wall time: 3.81 s
```

[46]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[47]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[48]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[49]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[49]: 0

1.60 Alpha 056

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
        rank((returns * cap))
```

[50]:
```
def alpha056(r, cap):
    """-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
        rank((returns * cap))
    """
    pass
```

1.61 Alpha 057

```
rank(ts_corr(ts_lag(open - close, 1), close, 200)) +
        rank(open - close)
```

[51]:
```
def alpha057(c, vwap):
    """-(close - vwap) / ts_weighted_mean(rank(ts_argmax(close, 30)), 2)"""
    return (c.sub(vwap.add(1e-5))
            .div(ts_weighted_mean(rank(ts_argmax(c, 30)))).mul(-1)
            .stack('ticker')
            .swaplevel())
```

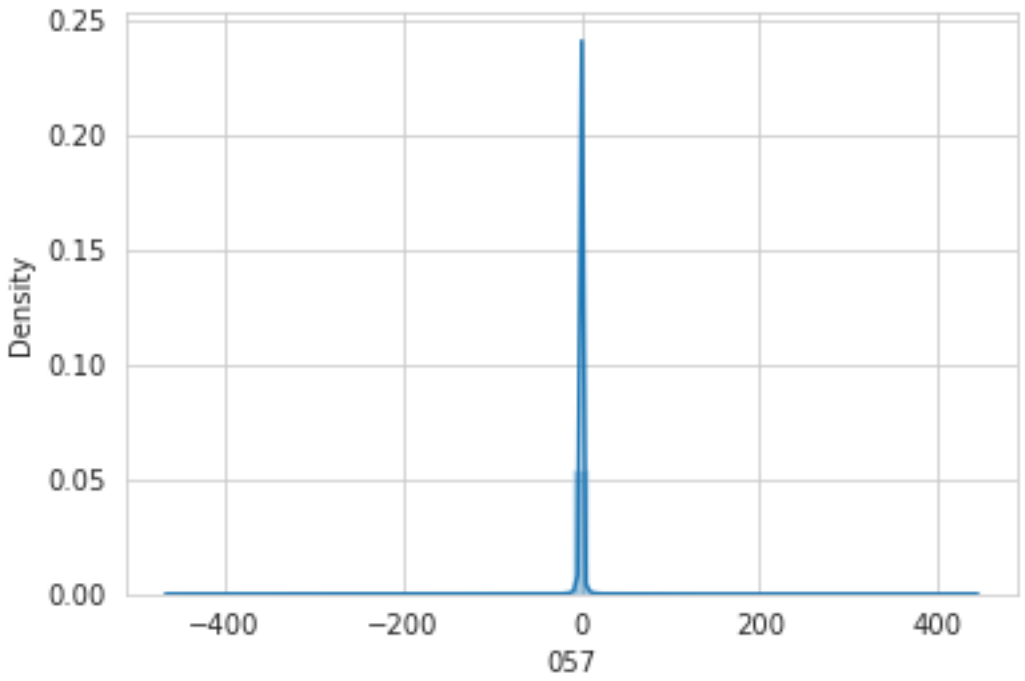
[52]:
```
alpha = 57
```

[53]:
```
%%time
alphas[f'{alpha:03}'] = alpha057(c, vwap)
```

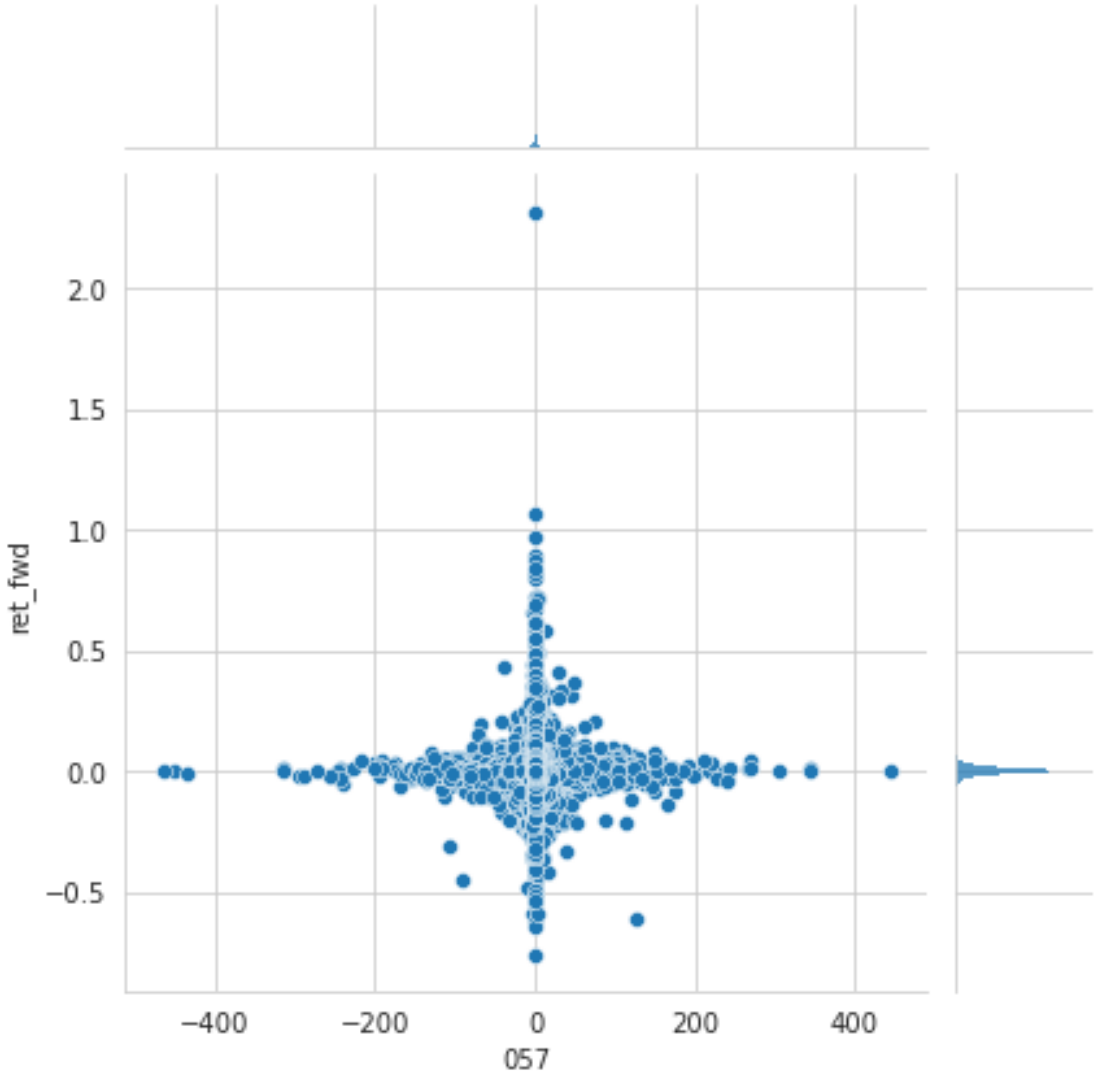
```
CPU times: user 1min 54s, sys: 280 ms, total: 1min 54s
Wall time: 1min 53s
```

[54]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[55]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[56]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[57]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[57]: 0.006408315924969266

1.62 Alpha 058

(indneutralize(((ts_corr(ts_delta(close, 1), ts_delta(ts_lag(close, 1), 1), 250) *ts_delta(clos

[58]:
```
def alpha58(v, wvap, sector):
    """(-1 * ts_rank(ts_weighted_mean(ts_corr(IndNeutralize(vwap, IndClass.
↪sector), volume, 3), 7), 5))"""
    pass
```

1.63 Alpha 059

(indneutralize(((ts_corr(ts_delta(close, 1), ts_delta(ts_lag(close, 1), 1), 250) *ts_delta(clos

[59]:
```
def alpha59(v, wvap, industry):
    """-ts_rank(ts_weighted_mean(ts_corr(IndNeutralize(vwap, IndClass.
↪industry), volume, 4), 16), 8)"""
    pass
```

1.64 Alpha 060

-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)

[60]:
```
def alpha060(l, h, c, v):
    """-((2 * scale(rank(((((close - low) - (high - close)) / (high - low)) *␣
↪volume)))) -scale(rank(ts_argmax(close, 10))))"""
    return (scale(rank(c.mul(2).sub(l).sub(h)
                       .div(h.sub(l).replace(0, 1e-5))
                       .mul(v))).mul(2)
            .sub(scale(rank(ts_argmax(c, 10)))).mul(-1)
            .stack('ticker')
            .swaplevel())
```

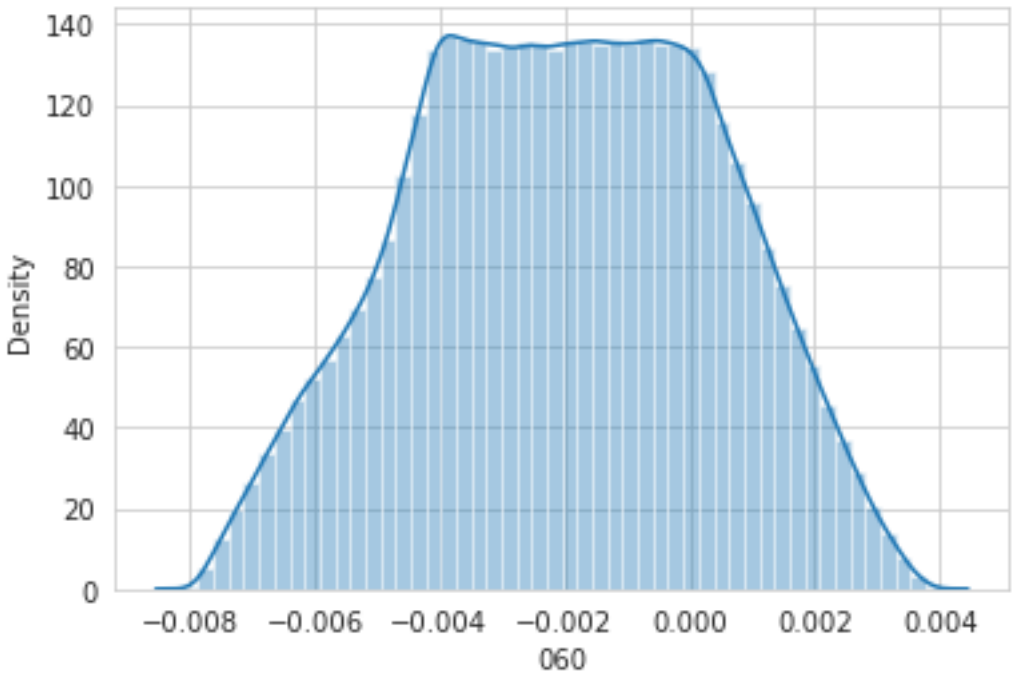
[61]:
```
alpha = 60
```

[62]:
```
%%time
alphas[f'{alpha:03}'] = alpha060(l, h, c, v)
```

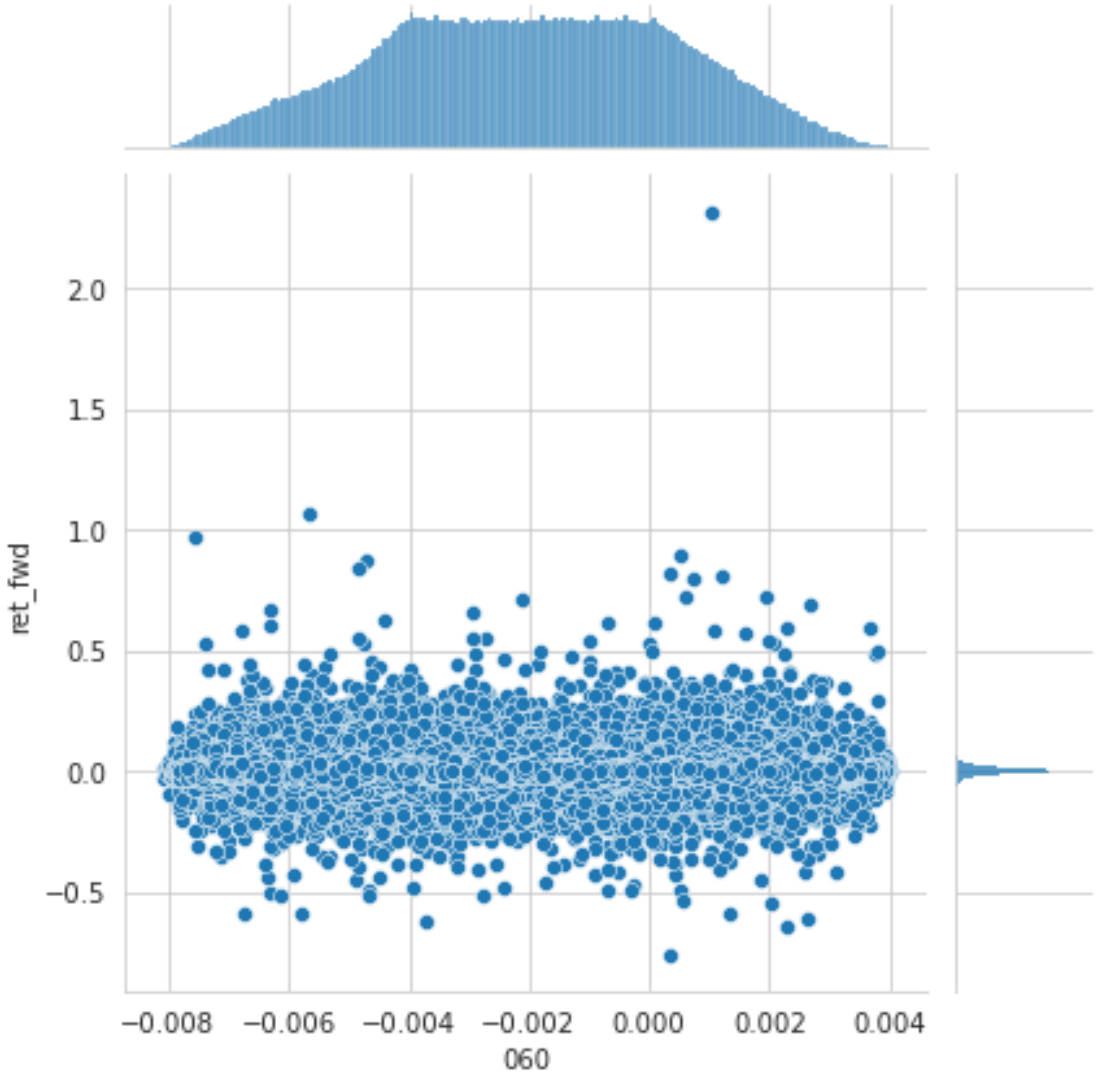
```
CPU times: user 1min 57s, sys: 372 ms, total: 1min 57s
Wall time: 1min 56s
```

[63]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[64]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[65]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[66]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[66]: 0

1.65 Alpha 061

(rank((vwap - ts_min(vwap, 16.1219))) < rank(ts_corr(vwap, adv180, 17.9282)))

[67]:
```
def alpha061(v, vwap):
    """rank((vwap - ts_min(vwap, 16))) < rank(ts_corr(vwap, adv180, 17))"""

    return (rank(vwap.sub(ts_min(vwap, 16)))
            .lt(rank(ts_corr(vwap, ts_mean(v, 180), 18))))
```

```
            .astype(int)
            .stack('ticker')
            .swaplevel())
```

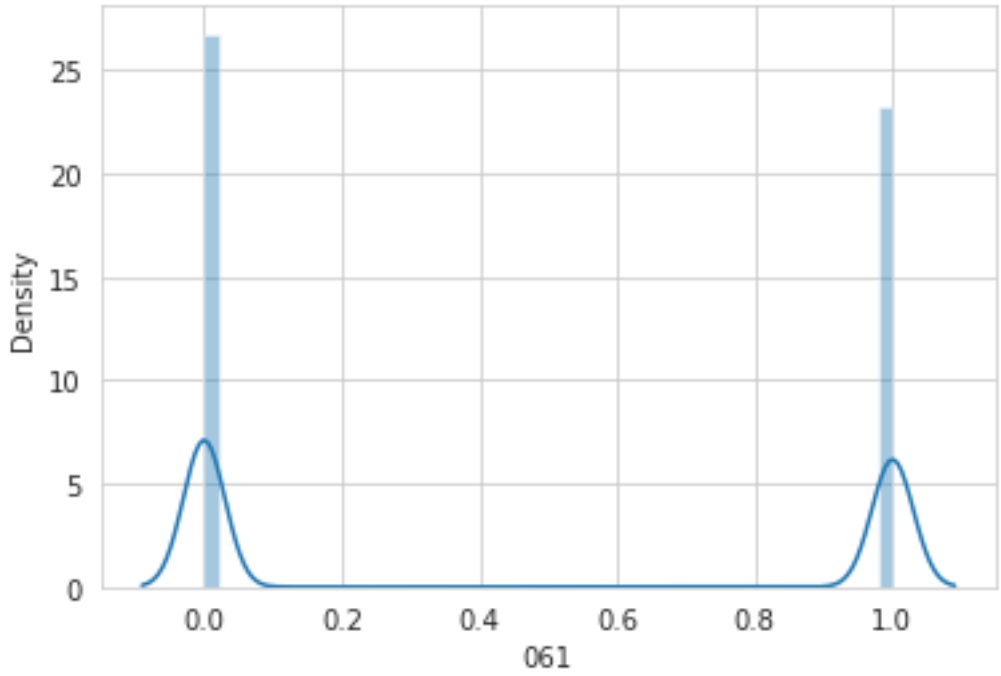
[68]:
```
alpha = 61
```

[69]:
```
%%time
alphas[f'{alpha:03}'] = alpha061(v, vwap)
```

```
CPU times: user 4.58 s, sys: 112 ms, total: 4.69 s
Wall time: 4.64 s
```

[70]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[71]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



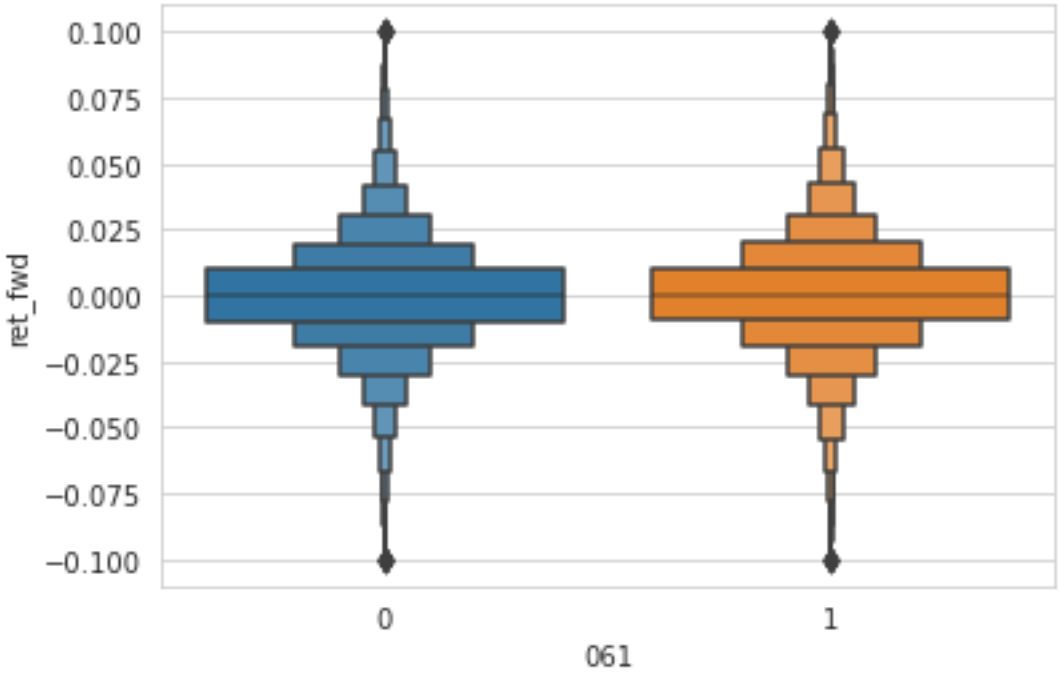
[72]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[72]:

061	count	mean	std	min	25%	50%	75%	max
0	671704.0	0.000458	0.025757	-0.757755	-0.009681	0.000413	0.010529	
1	583389.0	0.000724	0.025759	-0.643066	-0.009615	0.000599	0.010819	

```
0    2.317073
1    0.972222
```

[73]:
```
g = sns.boxenplot(x=f'{alpha:03}', y='ret_fwd', data=alphas[alphas.ret_fwd.
↪between(-.1, .1)]);
```



1.66 Alpha 062

((rank(ts_corr(vwap, ts_sum(adv20, 22.4101), 9.91009)) < rank(((rank(open) +rank(open)) < (rank

[74]:
```
def alpha062(o, h, l, vwap, adv20):
    """((rank(ts_corr(vwap, ts_sum(adv20, 22.4101), 9.91009)) <
    rank(((rank(open) + rank(open)) < (rank(((high + low) / 2)) +␣
↪rank(high))))) * -1)"""
    return (rank(ts_corr(vwap, ts_sum(adv20, 22), 9))
            .lt(rank(
                rank(o).mul(2))
                .lt(rank(h.add(l).div(2))
                    .add(rank(h))))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

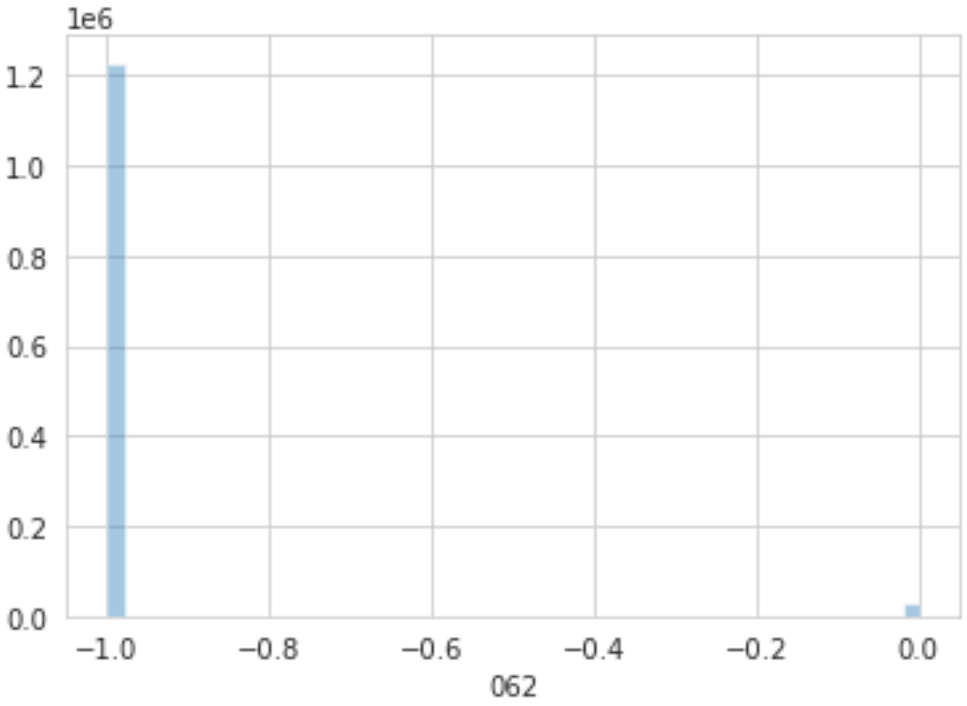
[75]:
```
alpha = 62
```

[76]:
```
%%time
alphas[f'{alpha:03}'] = alpha062(o, h, l, vwap, adv20)
```

```
CPU times: user 3.67 s, sys: 36.3 ms, total: 3.71 s
Wall time: 3.64 s
```

[77]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[78]:
```
sns.distplot(alphas[f'{alpha:03}'], kde=False);
```

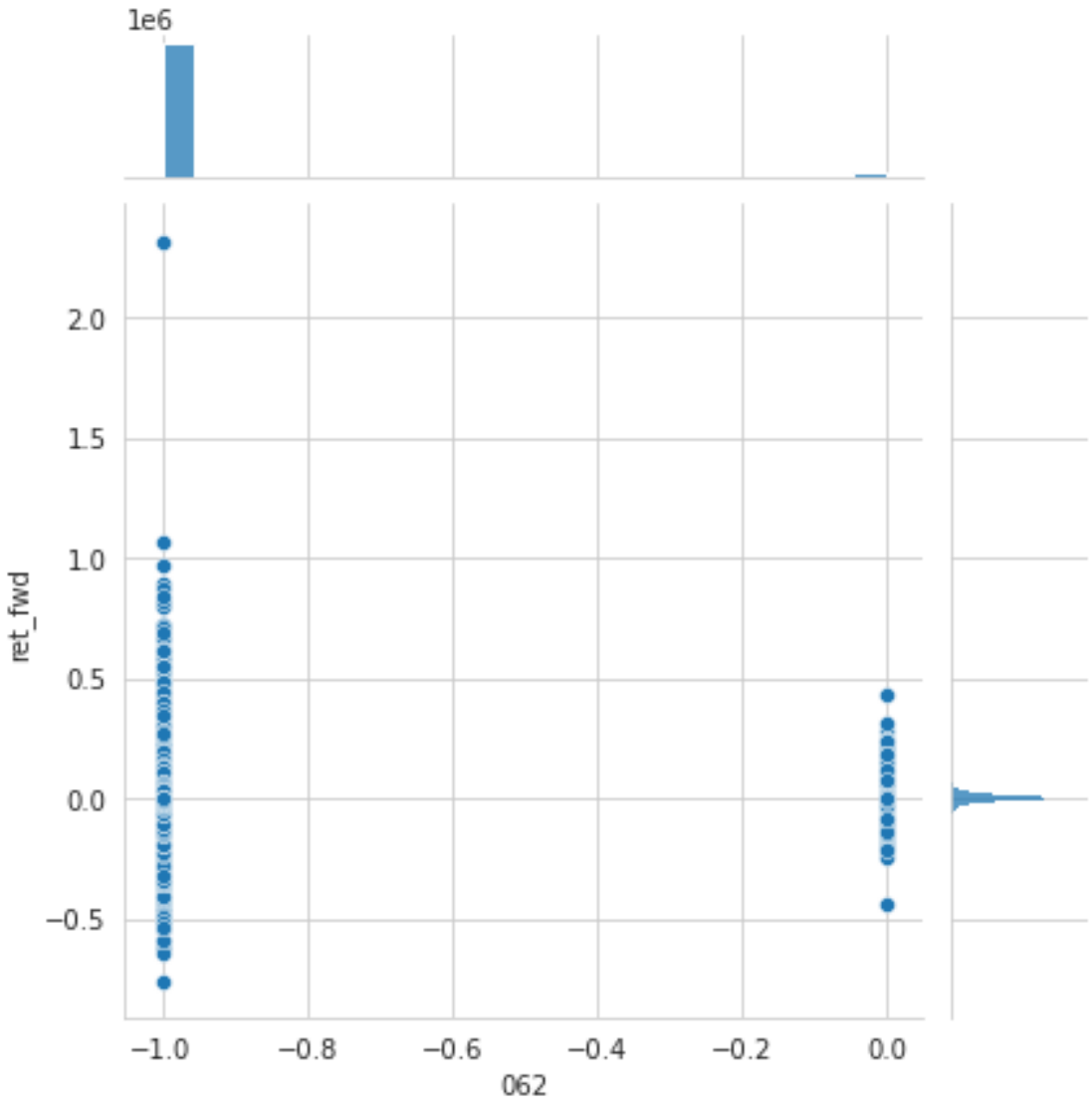


[79]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[79]:

062	count	mean	std	min	25%	50%	75%	max
-1	1227397.0	0.000582	0.025877	-0.757755	-0.009697	0.000496	0.010711	2.317073
0	27696.0	0.000545	0.019795	-0.441048	-0.007788	0.000648	0.008919	0.436170

[80]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[81]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.67 Alpha 063

((rank(ts_weighted_mean(ts_delta(IndNeutralize(close, IndClass.industry), 2.25164), 8.22237))-

[82]:
```
def alpha63(v, wvap, industry):
    """((rank(ts_weighted_mean(ts_delta(IndNeutralize(close, IndClass.
↪industry), 2), 8)) -
        rank(ts_weighted_mean(ts_corr(((vwap * 0.318108) + (open * (1 - 0.
↪318108))),
                                      ts_sum(adv180, 37), 13), 12))) * -1)
```

```
    """
    pass
```

[83]:
```
alpha = 63
```

[84]:
```
# %%time
# alphas[f'{alpha:03}'] = alpha48(o, c)
```

[85]:
```
# alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[86]:
```
# sns.distplot(alphas[f'{alpha:03}']);
```

[87]:
```
# g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
#
```

[88]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.68 Alpha 064

-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)

[89]:
```
def alpha064(o, h, l, v, vwap):
    """((rank(ts_corr(ts_sum(((open * 0.178404) + (low * (1 - 0.178404))), 12.
↪7054),ts_sum(adv120, 12.7054), 16.6208)) <
        rank(ts_delta((((high + low) / 2) * 0.178404) + (vwap * (1 -0.
↪178404))), 3.69741))) * -1)"""
    w = 0.178404
    return (rank(ts_corr(ts_sum(o.mul(w).add(l.mul(1 - w)), 12),
                         ts_sum(ts_mean(v, 120), 12), 16))
            .lt(rank(ts_delta(h.add(l).div(2).mul(w)
                              .add(vwap.mul(1 - w)), 3)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

[90]:
```
alpha = 64
```

[91]:
```
%%time
alphas[f'{alpha:03}'] = alpha064(o, h, l, v, vwap)
```

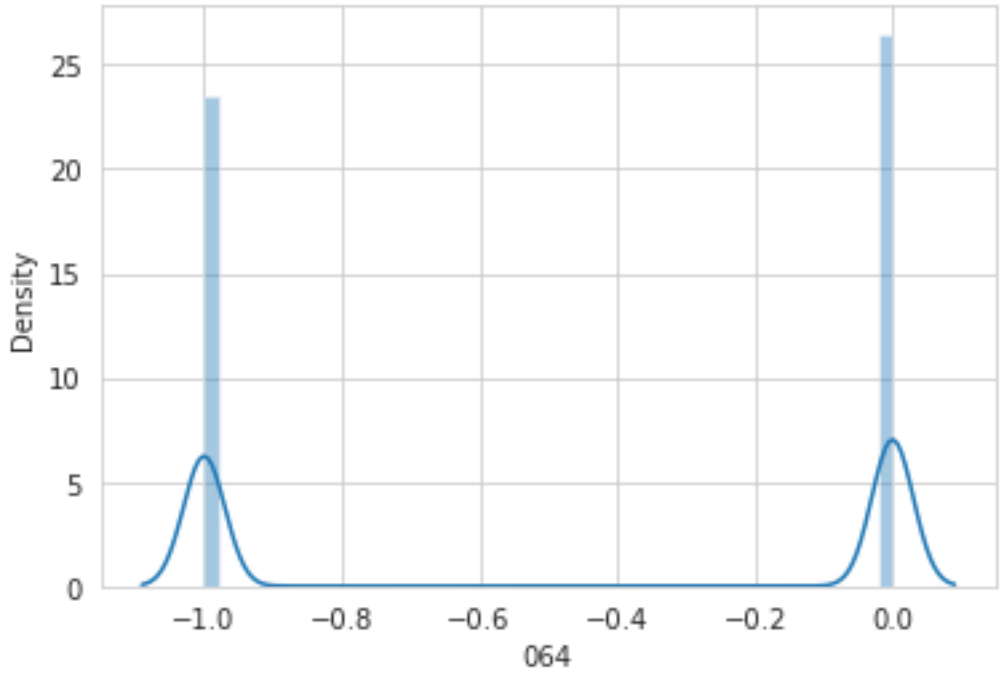
```
CPU times: user 3.74 s, sys: 40.3 ms, total: 3.79 s
Wall time: 3.69 s
```

[92]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

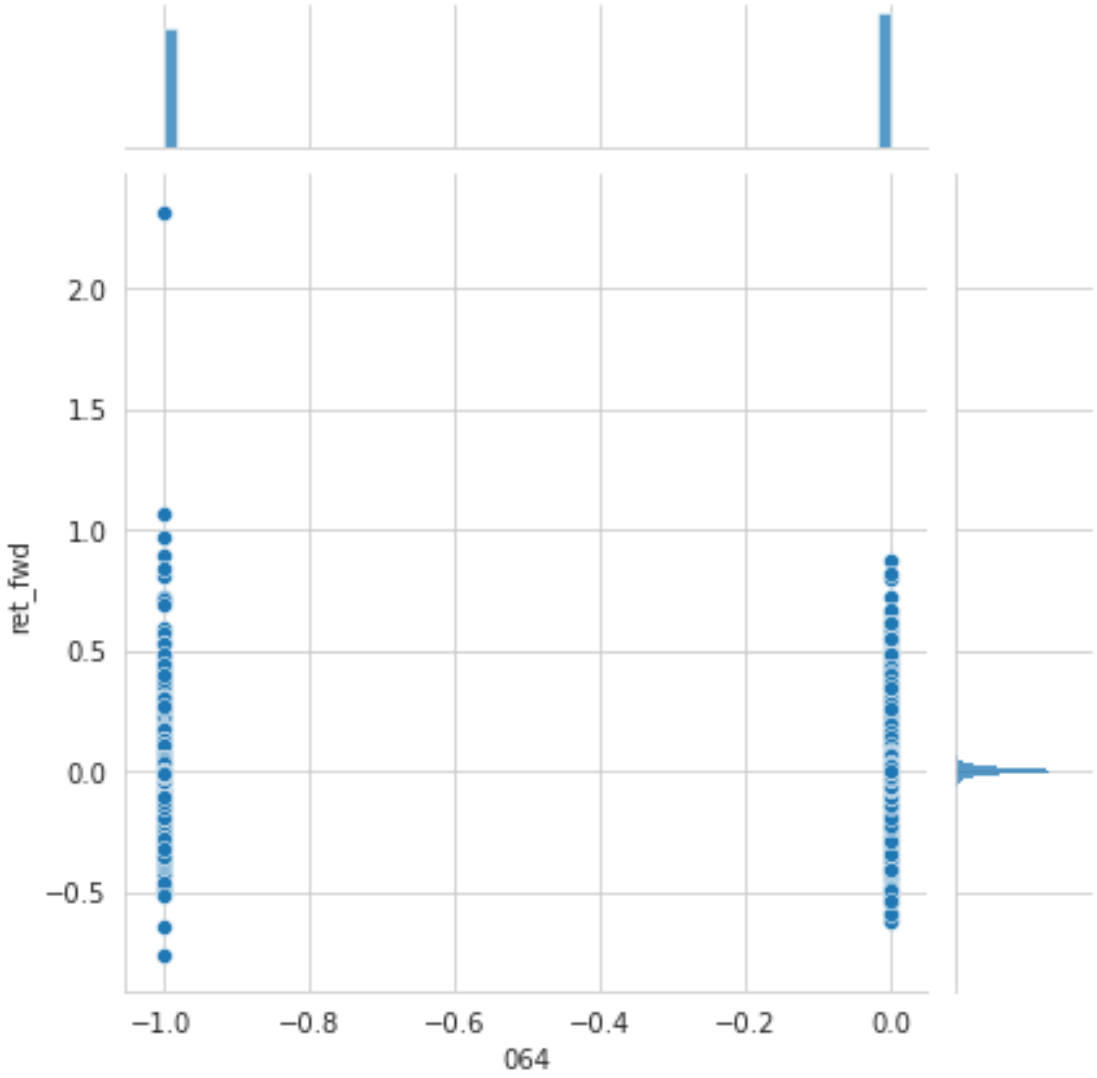
[93]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[93]:
```
          count      mean       std       min       25%       50%       75%  \
064
-1    590330.0  0.000463  0.025842 -0.757755 -0.009714  0.000410  0.010584
 0    664763.0  0.000687  0.025683 -0.619752 -0.009595  0.000576  0.010741

           max
064
-1    2.317073
 0    0.869835
```

[94]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[95]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.69 Alpha 065

```
((rank(ts_corr(((open * 0.00817205) + (vwap * (1 - 0.00817205))),
                        ts_sum(adv60,8.6911), 6.40374)) <
        rank((open - ts_min(open, 13.635)))) * -1)
```

[96]:
```
def alpha065(o, v, vwap):
    """((rank(ts_corr(((open * 0.00817205) + (vwap * (1 - 0.00817205))),
                        ts_sum(adv60,8.6911), 6.40374)) <
        rank((open - ts_min(open, 13.635)))) * -1)
    """
    w = 0.00817205
    return (rank(ts_corr(o.mul(w).add(vwap.mul(1 - w)),
                         ts_mean(ts_mean(v, 60), 9), 6))
```

```
            .lt(rank(o.sub(ts_min(o, 13))))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

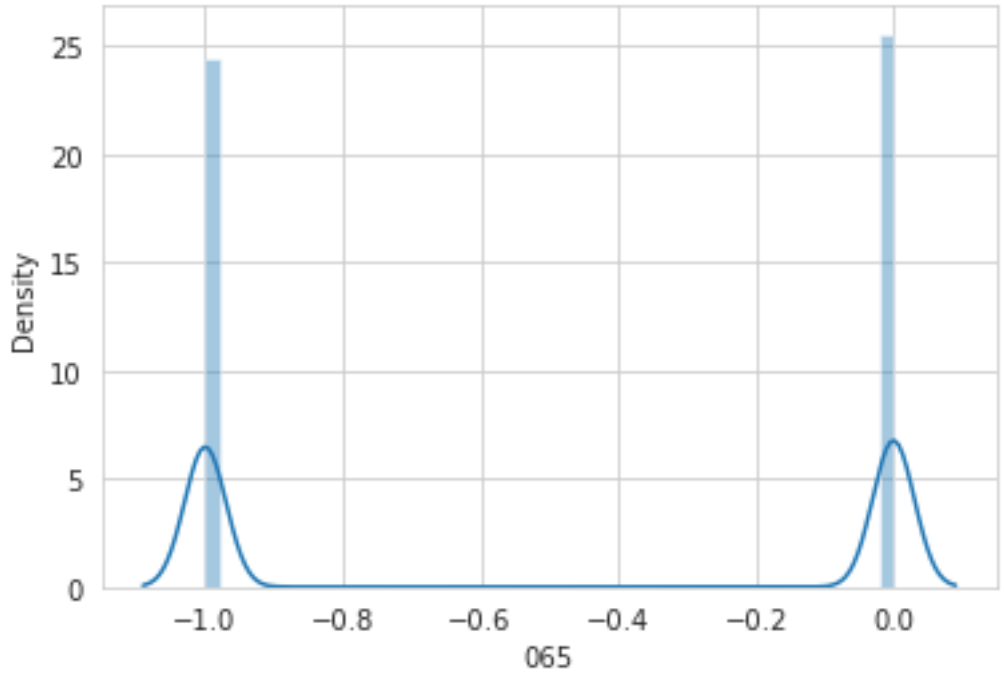
[97]:
```
alpha = 65
```

[98]:
```
%%time
alphas[f'{alpha:03}'] = alpha065(o, v, vwap)
```

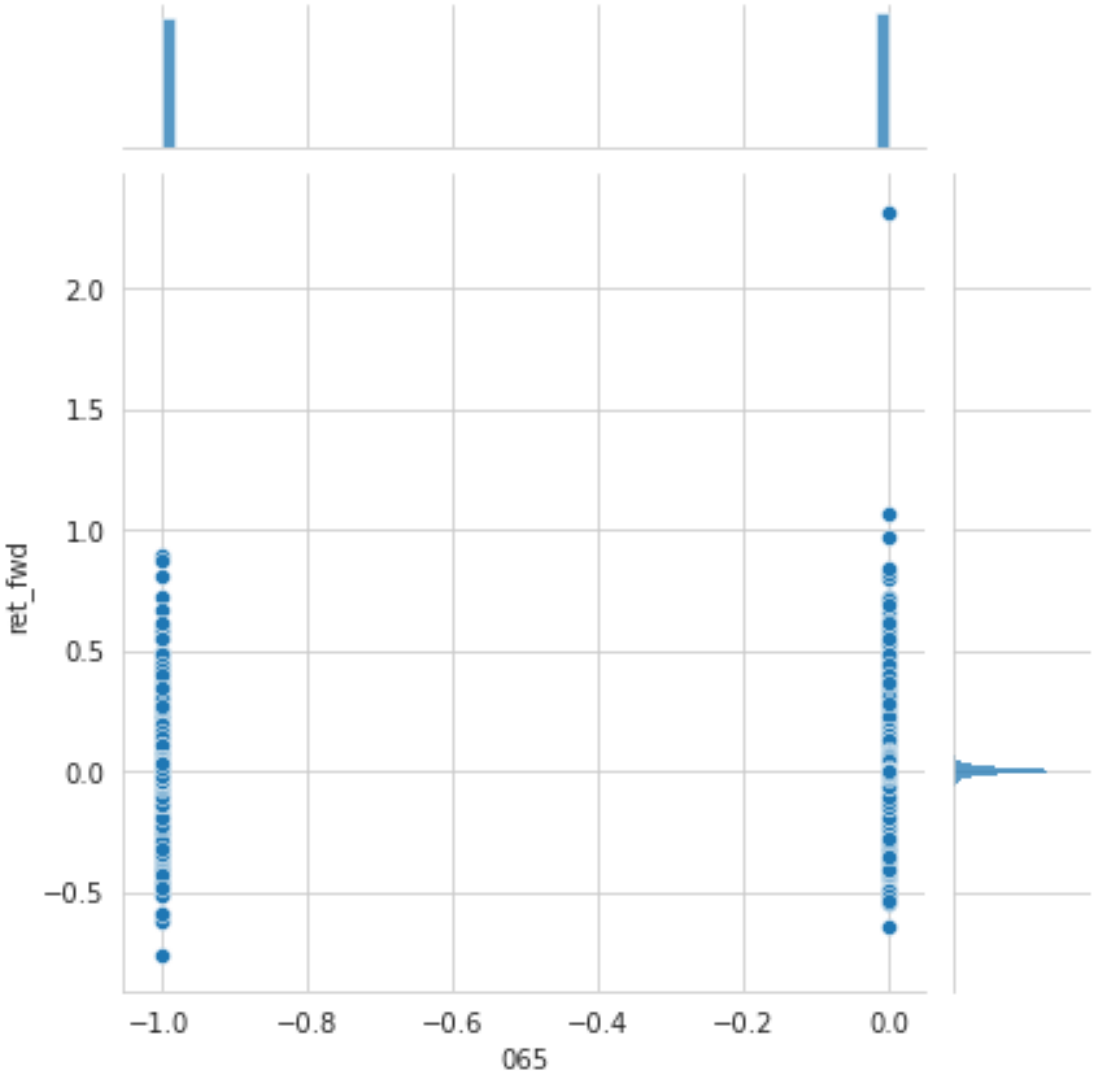
```
CPU times: user 3.83 s, sys: 32 ms, total: 3.86 s
Wall time: 3.79 s
```

[99]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[100]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[101]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.70 Alpha 066

```
((rank(ts_weighted_mean(ts_delta(vwap, 3.51013), 7.23052)) +
       ts_rank(ts_weighted_mean(((((low* 0.96633) + (low *
                                  (1 - 0.96633))) - vwap) /
                                  (open - ((high + low) / 2))), 11.4157), 6.72611)) * -1)
```

[102]:
```
def alpha066(l, h, vwap):
    """((rank(ts_weighted_mean(ts_delta(vwap, 3.51013), 7.23052)) +
        ts_rank(ts_weighted_mean(((((low* 0.96633) + (low *
                                   (1 - 0.96633))) - vwap) /
                                   (open - ((high + low) / 2))), 11.4157), 6.
↪72611)) * -1)
    """
```

```
    w = 0.96633
    return (rank(ts_weighted_mean(ts_delta(vwap, 4), 7))
            .add(ts_rank(ts_weighted_mean(l.mul(w).add(l.mul(1 - w))
                                          .sub(vwap)
                                          .div(o.sub(h.add(l).div(2))).
↪add(1e-3)), 11), 7))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

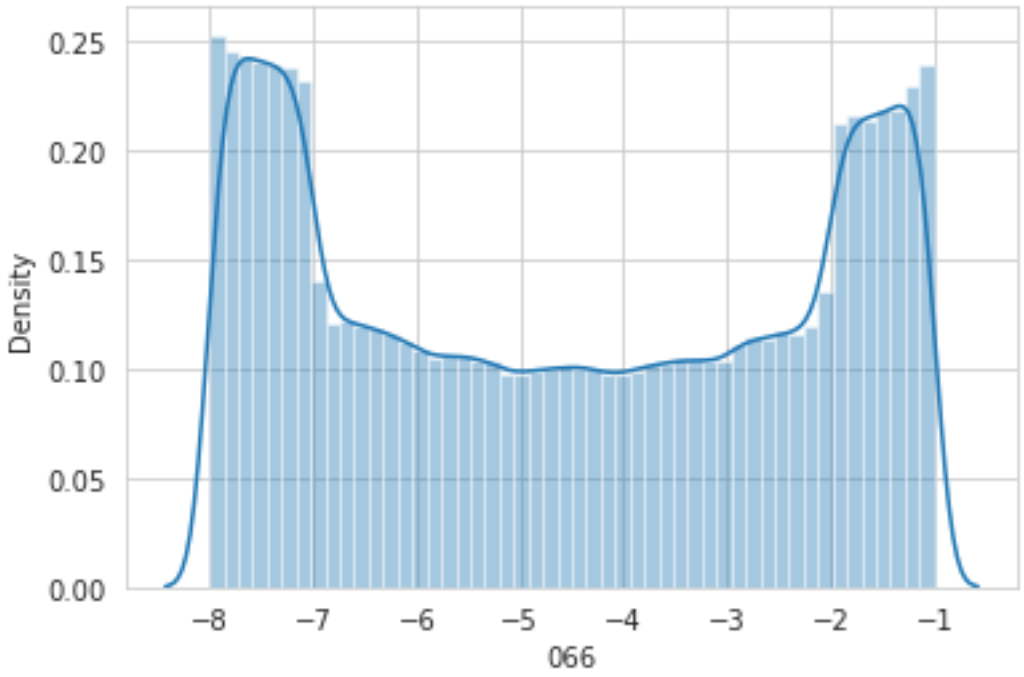
[103]:
```
alpha = 66
```

[104]:
```
%%time
alphas[f'{alpha:03}'] = alpha066(l, h, vwap)
```

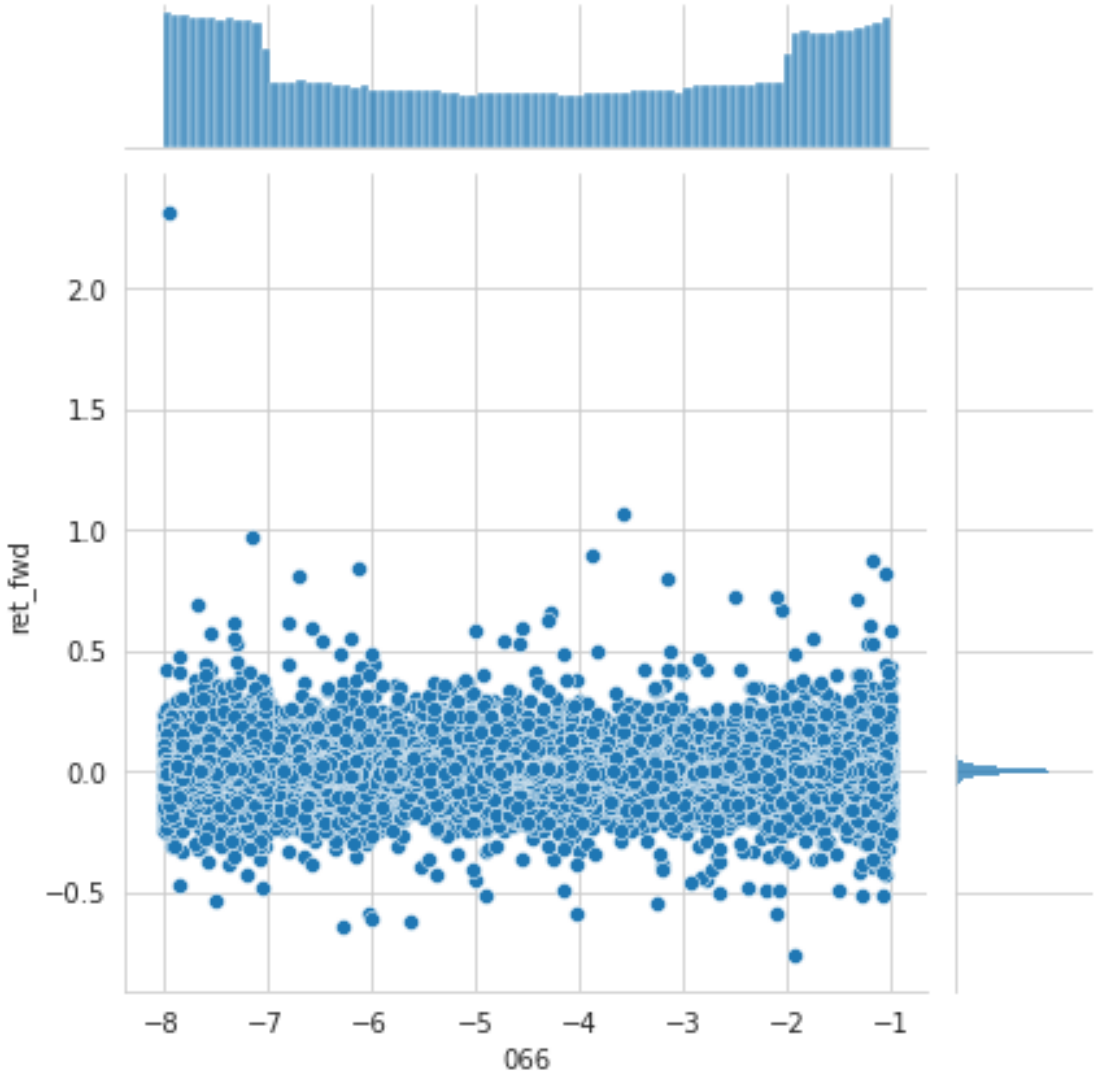
```
CPU times: user 3min, sys: 257 ms, total: 3min
Wall time: 3min
```

[105]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[106]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[107]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[108]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[108]: 0.009140875589292108

1.71 Alpha 067

(rank(ts_delta(IndNeutralize(((close * 0.60733) + (open * (1 - 0.60733))),IndClass.sector), 1.
rank(ts_corr(Ts_Rank(vwap, 3.60973), Ts_Rank(adv150,9.18637), 14.6644)))

[109]:
```
def alpha067(h, v, sector, subindustry):
    """(power(rank((high - ts_min(high, 2.14593))),
        rank(ts_corr(IndNeutralize(vwap,IndClass.sector),
                IndNeutralize(adv20, IndClass.subindustry), 6.02936))) * -1)
```

```
    """
    pass
```

[110]:
```
alpha = 67
```

[111]:
```
# %%time
# alphas[f'{alpha:03}'] = alpha056(r, cap)
```

[112]:
```
# alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[113]:
```
# sns.distplot(alphas[f'{alpha:03}']);
```

[114]:
```
# g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
#
```

[115]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.72 Alpha 068

```
((ts_rank(ts_corr(rank(high), rank(adv15), 8.91644), 13.9333) <
        rank(ts_delta(((close * 0.518371) + (low * (1 - 0.518371))), 1.06157))) * -1)
```

[116]:
```
def alpha068(h, c, v):
    """((ts_rank(ts_corr(rank(high), rank(adv15), 8.91644), 13.9333) <
        rank(ts_delta(((close * 0.518371) + (low * (1 - 0.518371))), 1.06157)))␣
 ↪* -1)
    """
    w = 0.518371
    return (ts_rank(ts_corr(rank(h), rank(ts_mean(v, 15)), 9), 14)
            .lt(rank(ts_delta(c.mul(w).add(l.mul(1 - w)), 1)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

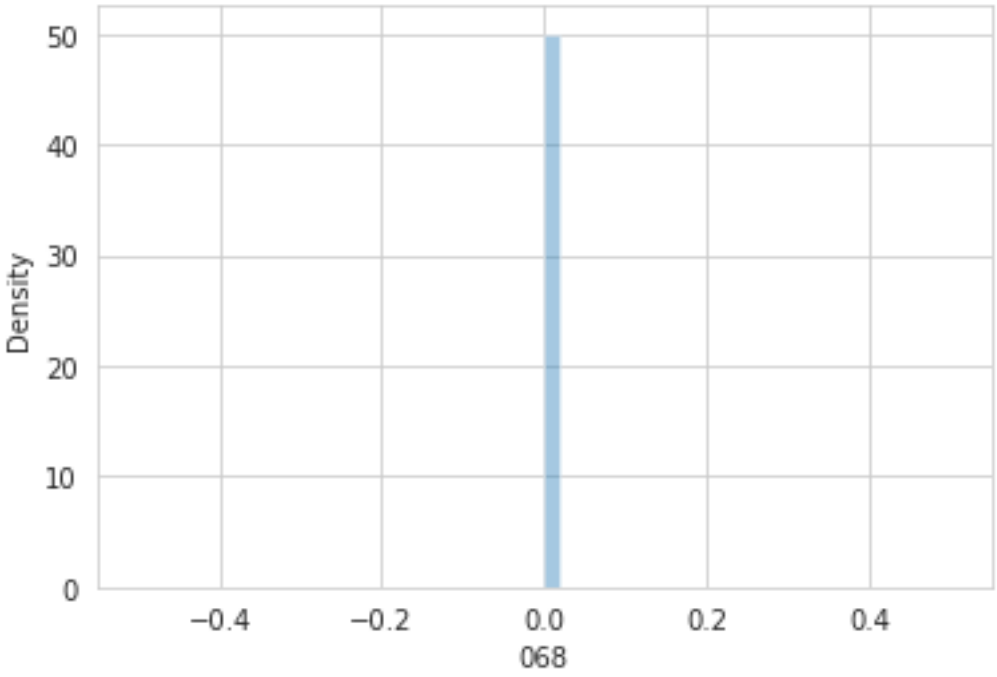
[117]:
```
alpha = 68
```

[118]:
```
%%time
alphas[f'{alpha:03}'] = alpha068(h, c, v)
```

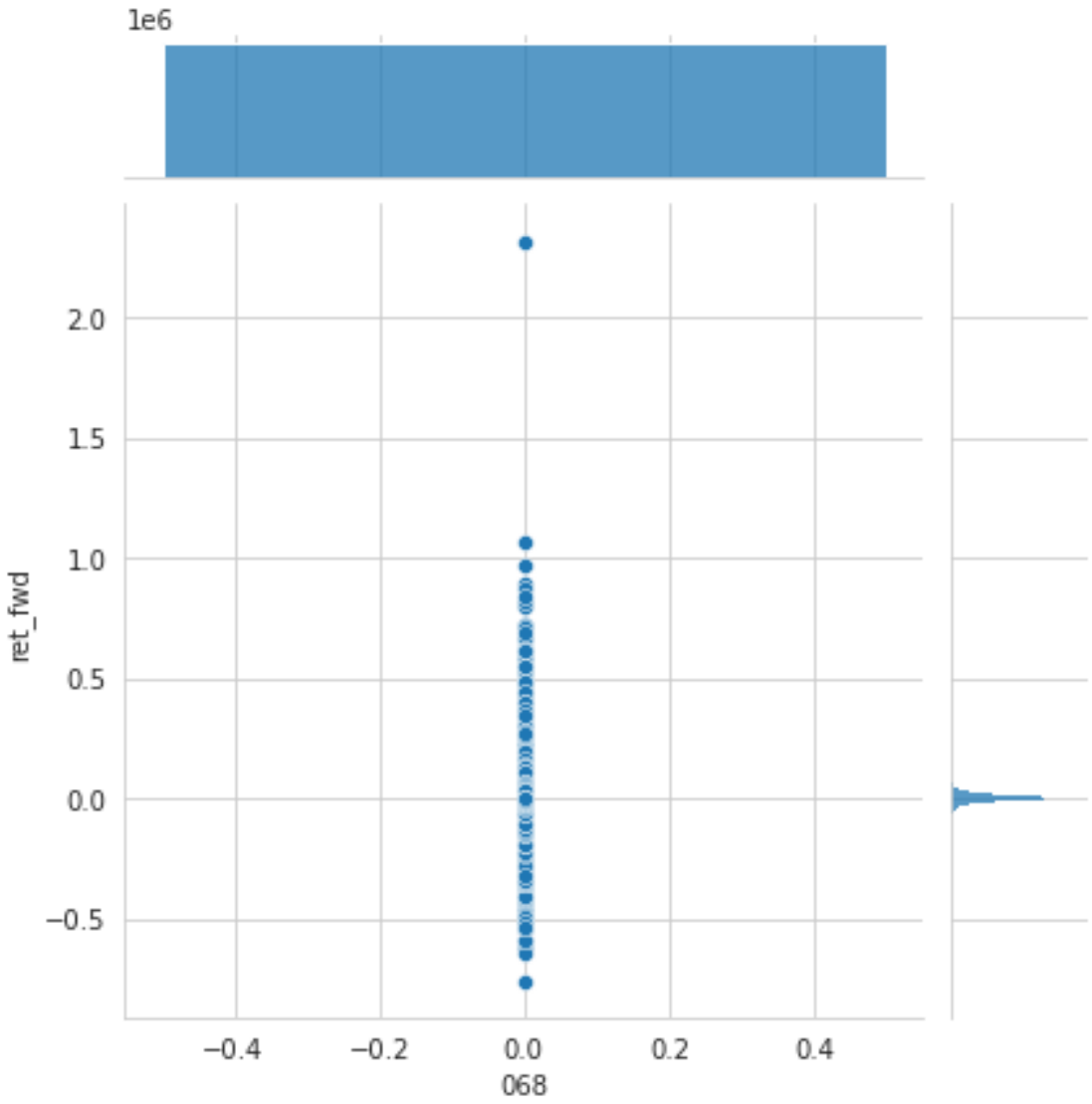
```
CPU times: user 2min 54s, sys: 66.2 ms, total: 2min 54s
Wall time: 2min 54s
```

[119]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[120]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[121]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.73 Alpha 069

```
((power(rank(ts_max(ts_delta(IndNeutralize(vwap, IndClass.industry), 2.72412),4.79344)),
       Ts_Rank(ts_corr(((close * 0.490655) + (vwap * (1 - 0.490655))), adv20, 4.92416),9.0615)
```

[122]:
```
def alpha069(c, vwap, industry):
    """((power(rank(ts_max(ts_delta(IndNeutralize(vwap, IndClass.industry), 2.
↪72412),4.79344)),
    Ts_Rank(ts_corr(((close * 0.490655) + (vwap * (1 - 0.490655))), adv20, 4.
↪92416),9.0615))) * -1)
    """
    pass
```

1.74 Alpha 070

((power(rank(ts_delta(vwap, 1.29456)),
        ts_rank(ts_corr(IndNeutralize(close,IndClass.industry), adv50, 17.8256), 17.9171))) *

[123]:
```
def alpha076(c, v, vwap, industry):
    """((power(rank(ts_delta(vwap, 1.29456)),
        ts_rank(ts_corr(IndNeutralize(close, IndClass.industry), adv50, 17.
↪8256), 17.9171))) * -1)
    """
    pass
```

[124]:
```
alpha = 70
```

1.75 Alpha 071

-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)

[125]:
```
def alpha071(o, c, v, vwap):
    """max(ts_rank(ts_weighted_mean(ts_corr(ts_rank(close, 3.43976),␣
↪ts_rank(adv180,12.0647), 18.0175), 4.20501), 15.6948),
            ts_rank(ts_weighted_mean((rank(((low + open) - (vwap +vwap)))^2),␣
↪16.4662), 4.4388))"""

    s1 = (ts_rank(ts_weighted_mean(ts_corr(ts_rank(c, 3),
                                           ts_rank(ts_mean(v, 180), 12), 18),␣
↪4), 16))
    s2 = (ts_rank(ts_weighted_mean(rank(l.add(o).
                                        sub(vwap.mul(2)))
                                   .pow(2), 16), 4))
    return (s1.where(s1 > s2, s2)
            .stack('ticker')
            .swaplevel())
```

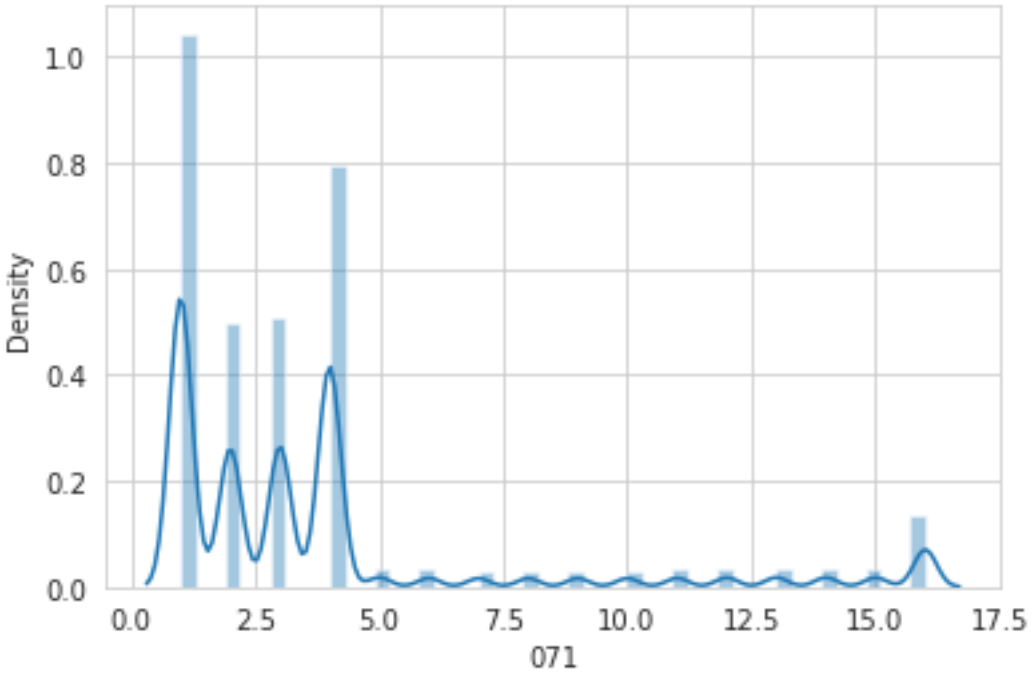
[126]:
```
alpha = 71
```

[127]:
```
%%time
alphas[f'{alpha:03}'] = alpha071(o, c, v, vwap)
```

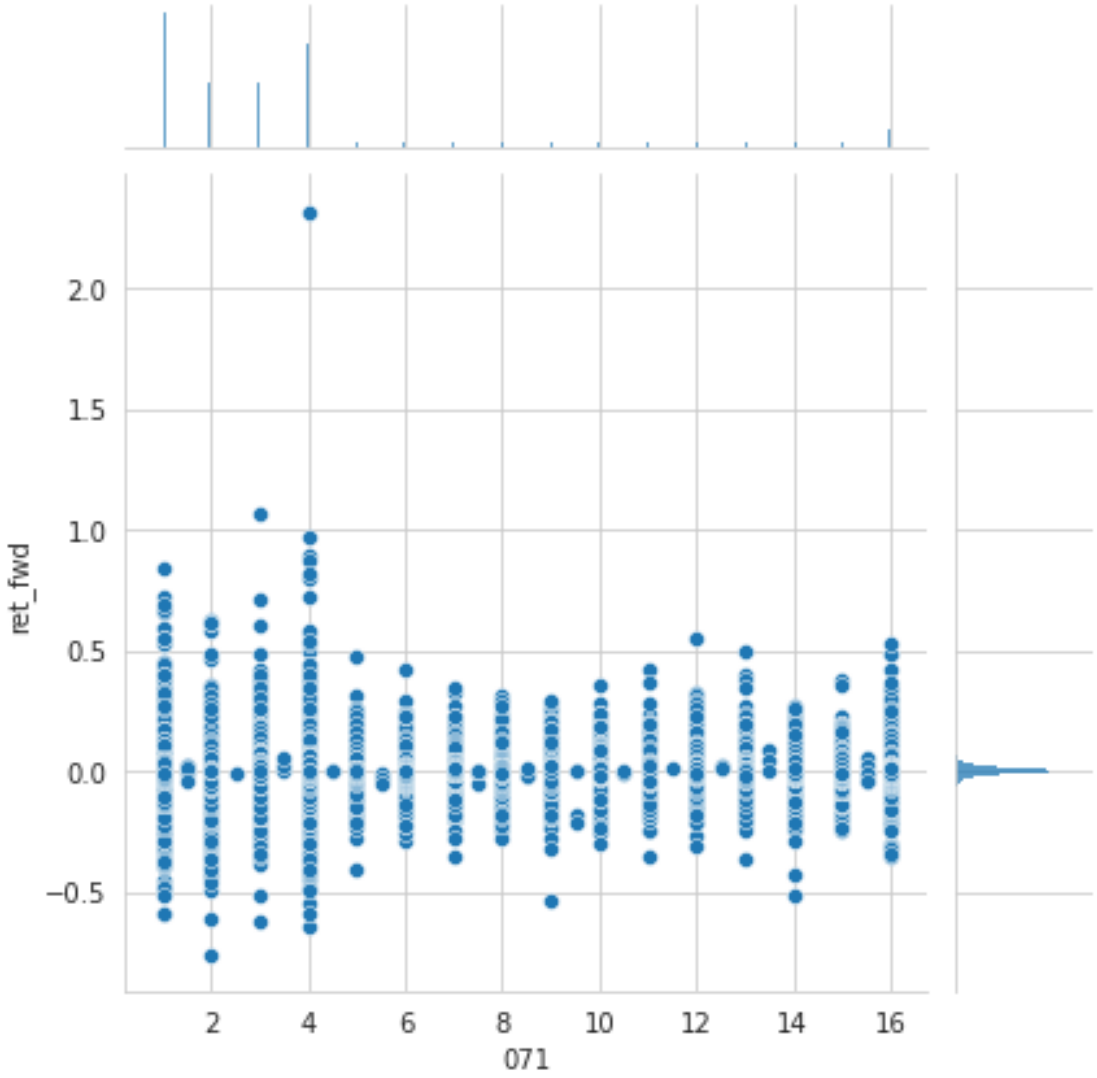
```
CPU times: user 9min 28s, sys: 81.3 ms, total: 9min 29s
Wall time: 9min 28s
```

[128]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[129]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[130]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[131]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[131]: 0.002330970321091197

1.76 Alpha 072

```
(rank(ts_weighted_mean(ts_corr(((high + low) / 2), adv40, 8.93345), 10.1519)) /
       rank(ts_weighted_mean(ts_corr(ts_rank(vwap, 3.72469), ts_rank(volume, 18.5188), 6.8667
```

[132]:
```
def alpha072(h, l, v, vwap):
    """(rank(ts_weighted_mean(ts_corr(((high + low) / 2), adv40, 8.93345), 10.
 ↪1519)) /
```

```
        rank(ts_weighted_mean(ts_corr(ts_rank(vwap, 3.72469), ts_rank(volume,␣
↪18.5188), 6.86671), 2.95011)))
    """
    return (rank(ts_weighted_mean(ts_corr(h.add(l).div(2), ts_mean(v, 40), 9),␣
↪10))
            .div(rank(ts_weighted_mean(ts_corr(ts_rank(vwap, 3), ts_rank(v,␣
↪18), 6), 2)))
            .stack('ticker')
            .swaplevel())
```

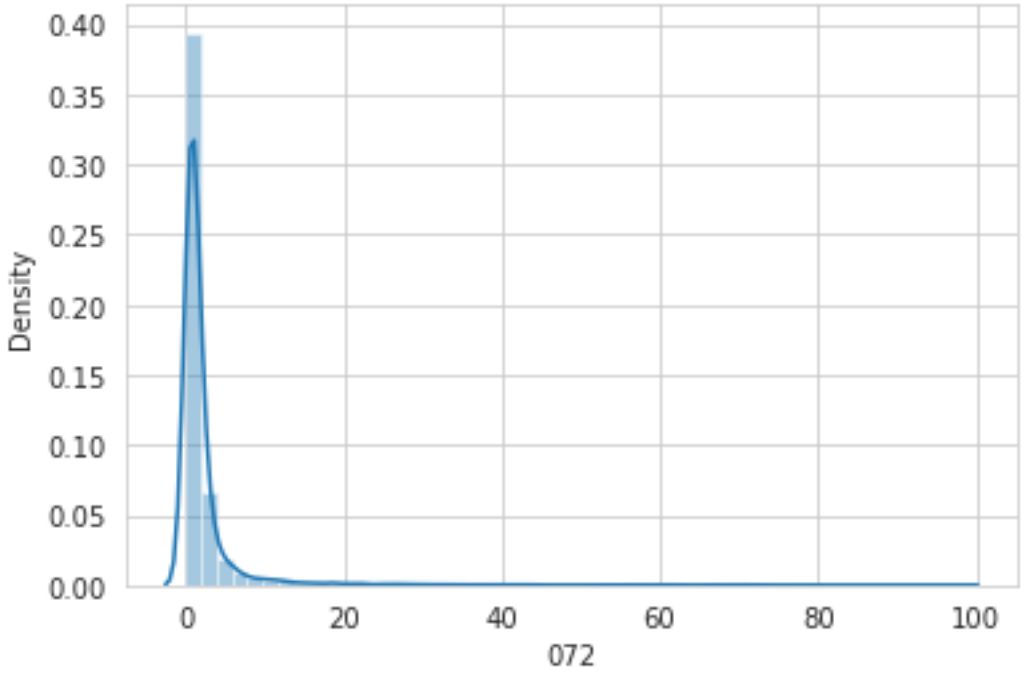
[133]:
```
alpha = 72
```

[134]:
```
%%time
alphas[f'{alpha:03}'] = alpha072(h, l, v, vwap)
```

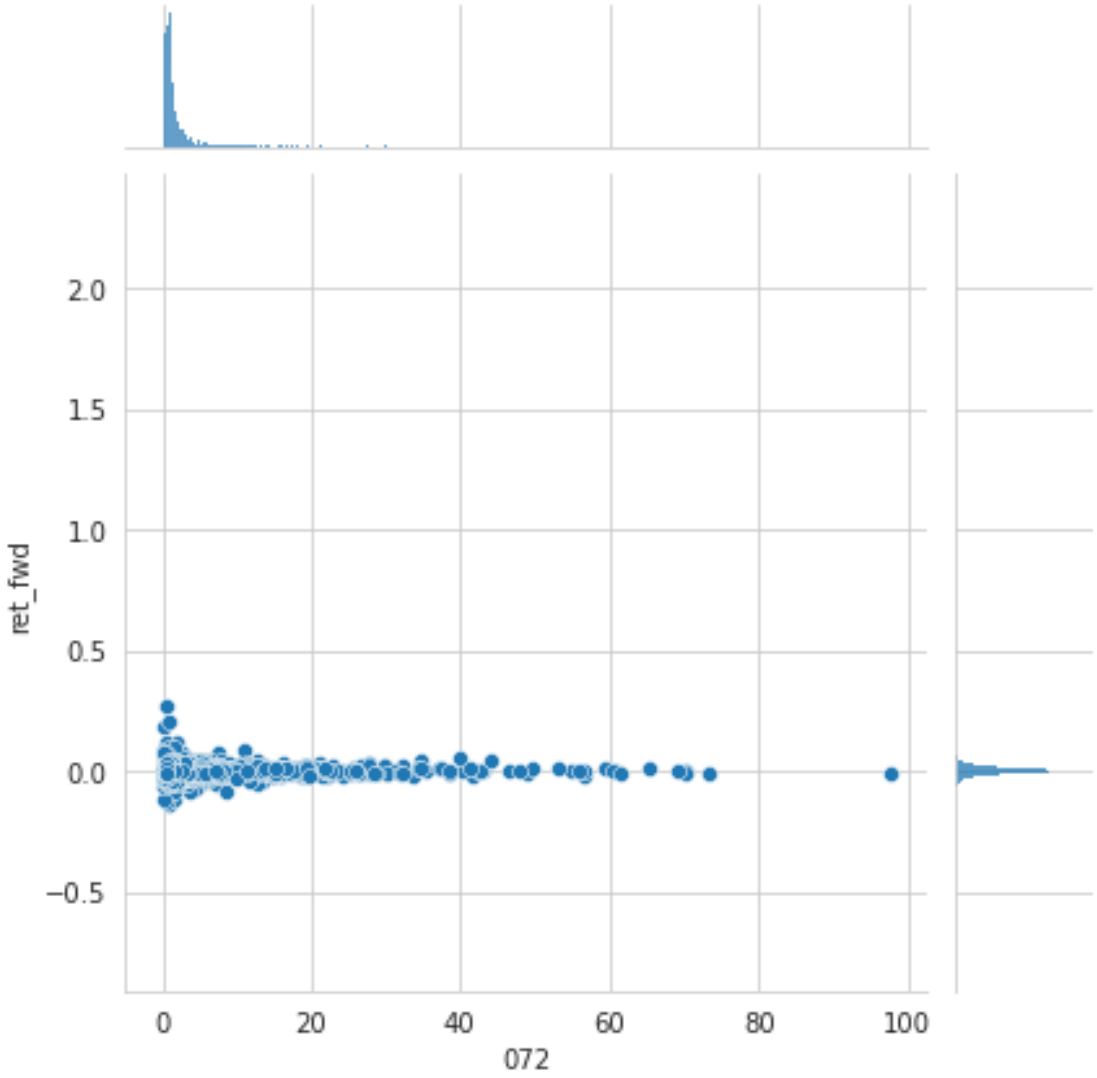
```
CPU times: user 6min 5s, sys: 95.2 ms, total: 6min 5s
Wall time: 6min 4s
```

[135]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[136]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[137]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



1.77 Alpha 073

```
(max(rank(ts_weighted_mean(ts_delta(vwap, 4.72775), 2.91864)),
       ts_rank(ts_weighted_mean(((ts_delta(((open * 0.147155) +
           (low * (1 - 0.147155))), 2.03608) /
           ((open *0.147155) + (low * (1 - 0.147155)))) * -1), 3.33829), 16.7411)) * -1)
```

[138]:
```
def alpha073(l, vwap):
    """(max(rank(ts_weighted_mean(ts_delta(vwap, 4.72775), 2.91864)),
        ts_rank(ts_weighted_mean(((ts_delta(((open * 0.147155) +
            (low * (1 - 0.147155))), 2.03608) /
            ((open *0.147155) + (low * (1 - 0.147155)))) * -1), 3.33829), 16.
↪7411)) * -1)
        """
```

```
    w = 0.147155
    s1 = rank(ts_weighted_mean(ts_delta(vwap, 5), 3))
    s2 = (ts_rank(ts_weighted_mean(ts_delta(o.mul(w).add(l.mul(1 - w)), 2)
                                   .div(o.mul(w).add(l.mul(1 - w)).mul(-1)),␣
↪3), 16))

    print(s2)
    return (s1.where(s1 > s2, s2)
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

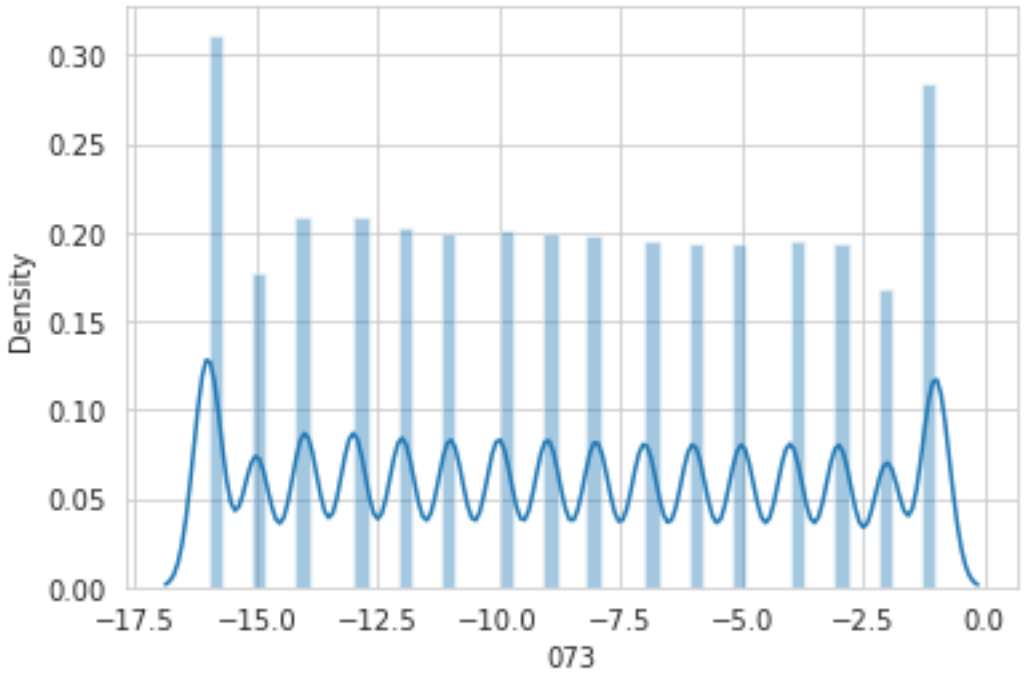
[139]:
```
alpha = 73
```

[140]:
```
# %%time
alphas[f'{alpha:03}'] = alpha073(l, vwap)
```

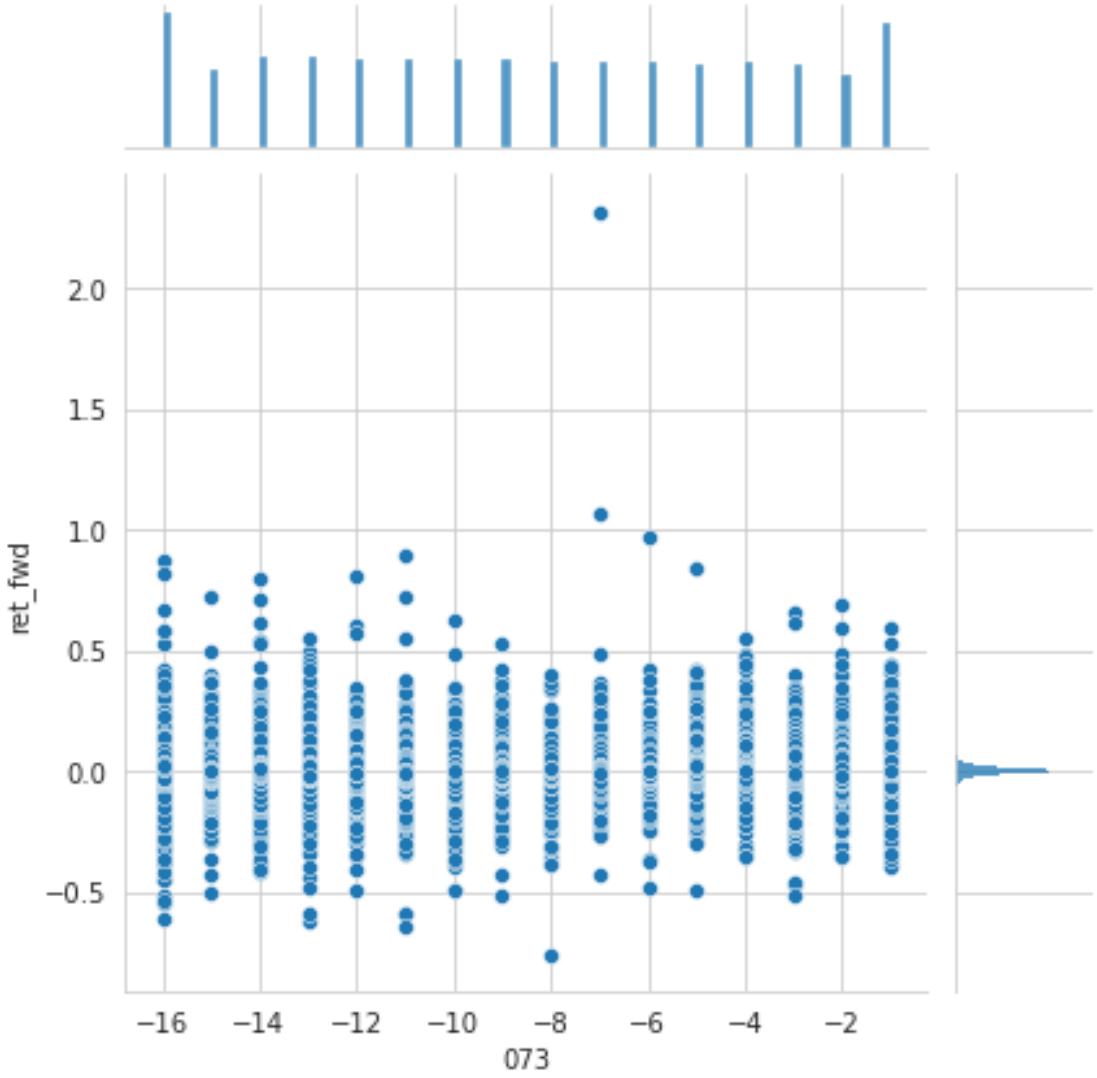
```
ticker         A   AAL   AAP  AAPL   ABC  ABT   ACN  ADBE   ADI   ADM  … \
date                                                                    …
2007-01-04   NaN   NaN   NaN   NaN   NaN  NaN   NaN   NaN   NaN   NaN  …
2007-01-05   NaN   NaN   NaN   NaN   NaN  NaN   NaN   NaN   NaN   NaN  …
2007-01-08   NaN   NaN   NaN   NaN   NaN  NaN   NaN   NaN   NaN   NaN  …
2007-01-09   NaN   NaN   NaN   NaN   NaN  NaN   NaN   NaN   NaN   NaN  …
2007-01-10   NaN   NaN   NaN   NaN   NaN  NaN   NaN   NaN   NaN   NaN  …
…            …     …     …     …     …    …     …     …     …     …  …
2016-12-22   8.0   5.0  11.0  12.0   9.0  7.0  16.0  10.0   6.0  14.0  …
2016-12-23  10.0  14.0  15.0  14.0  12.0  6.0  15.0  12.0   8.0  15.0  …
2016-12-27   7.0  16.0  13.0  13.0  10.0  5.0  12.0  11.0   7.0  13.0  …
2016-12-28  11.0  16.0  10.0  11.0   7.0  6.0  12.0  14.0   7.0  11.0  …
2016-12-29  14.0  16.0  10.0  12.0   6.0  9.0  12.0  14.0  13.0   9.0  …

ticker       XEC   XEL    XL  XLNX   XOM  XRAY   XRX   YUM   ZBH  ZION
date
2007-01-04   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
2007-01-05   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
2007-01-08   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
2007-01-09   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
2007-01-10   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
…            …     …     …     …     …     …     …     …     …     …
2016-12-22  13.0  10.0   3.0   5.0  15.0  13.0  10.0  11.0  11.0   9.0
2016-12-23  12.0  11.0   4.0   7.0   9.0  14.0  14.0  12.0   9.0  10.0
2016-12-27   8.0  11.0   4.0   9.0   6.0  11.0  13.0  12.0   7.0  12.0
2016-12-28   7.0  15.0   7.0  11.0   8.0  14.0  15.0  11.0   5.0  12.0
2016-12-29   8.0  16.0  13.0  16.0  15.0  16.0  15.0  13.0   5.0  15.0

[2516 rows x 500 columns]
```

[141]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[142]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[143]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[144]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[144]: 0.0019621236363676076

1.78 Alpha 074

```
((rank(ts_corr(close, ts_sum(adv30, 37.4843), 15.1365)) <
       rank(ts_corr(rank(((high * 0.0261661) + (vwap * (1 - 0.0261661)))), rank(volume), 11.4
```

[145]:
```
def alpha074(v, vwap):
    """((rank(ts_corr(close, ts_sum(adv30, 37.4843), 15.1365)) <
        rank(ts_corr(rank(((high * 0.0261661) + (vwap * (1 - 0.0261661)))),␣
 ↪rank(volume), 11.4791)))* -1)"""
```

```
    w = 0.0261661
    return (rank(ts_corr(c, ts_mean(ts_mean(v, 30), 37), 15))
            .lt(rank(ts_corr(rank(h.mul(w).add(vwap.mul(1 - w))), rank(v), 11)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

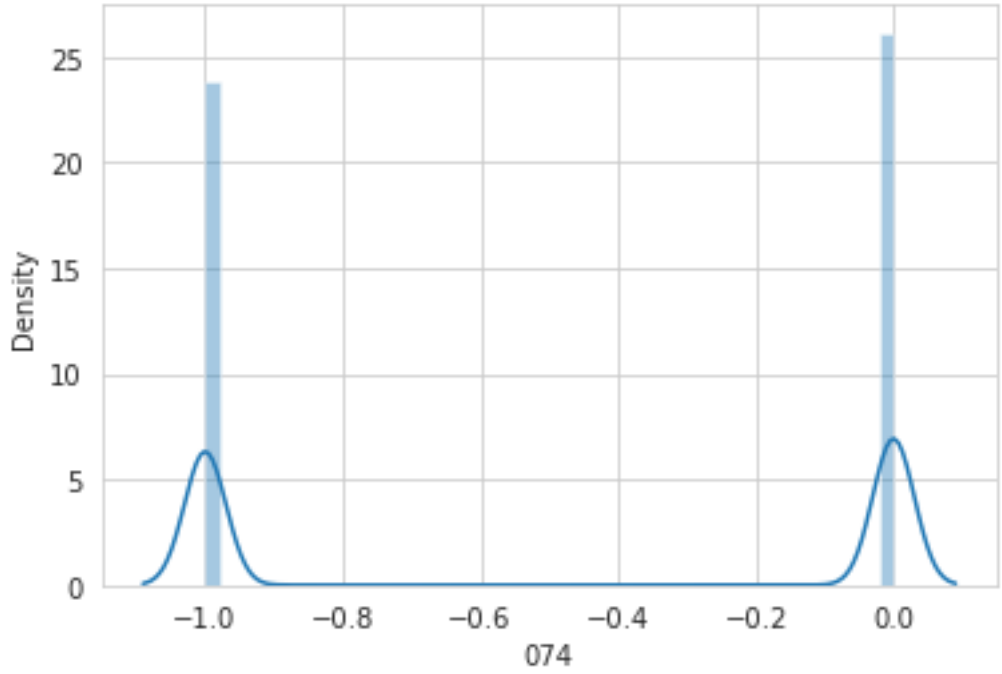
[146]:
```
alpha = 74
```

[147]:
```
%%time
alphas[f'{alpha:03}'] = alpha074(v, vwap)
```

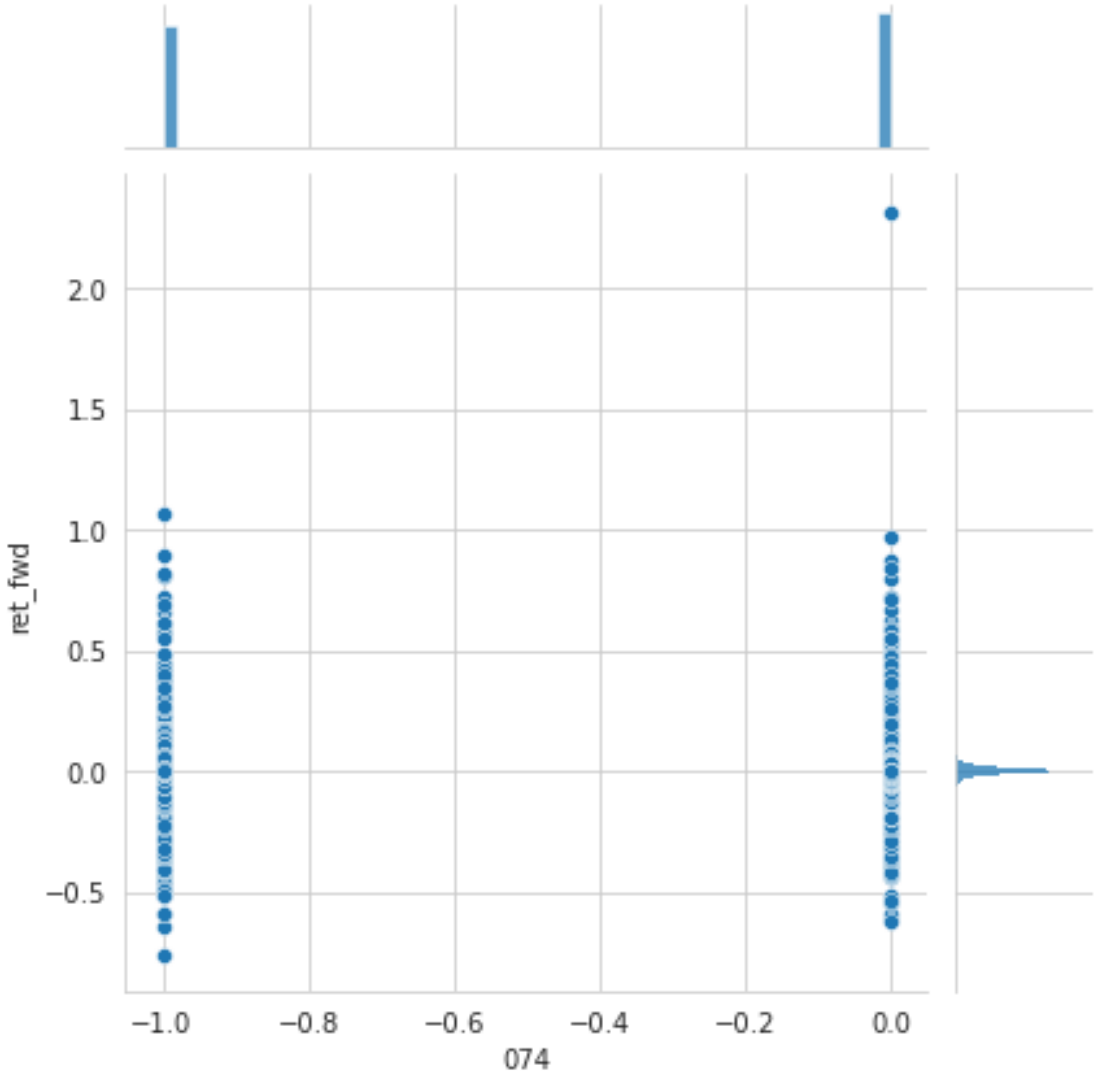
```
CPU times: user 4.76 s, sys: 64 ms, total: 4.82 s
Wall time: 4.73 s
```

[148]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[149]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[150]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[151]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[151]:

074	count	mean	std	min	25%	50%	75%	max
-1	598745.0	0.000563	0.026009	-0.757755	-0.009807	0.000456	0.010752	1.061026
0	656348.0	0.000599	0.025527	-0.619752	-0.009509	0.000538	0.010582	2.317073

1.79 Alpha 075

```
(rank(ts_corr(vwap, volume, 4.24304)) <
        rank(ts_corr(rank(low), rank(adv50),12.4413)))
```

[152]:
```
def alpha075(l, v, vwap):
    """(rank(ts_corr(vwap, volume, 4.24304)) <
        rank(ts_corr(rank(low), rank(adv50),12.4413)))
    """

    return (rank(ts_corr(vwap, v, 4))
            .lt(rank(ts_corr(rank(l), rank(ts_mean(v, 50)), 12)))
            .astype(int)
            .stack('ticker')
            .swaplevel())
```

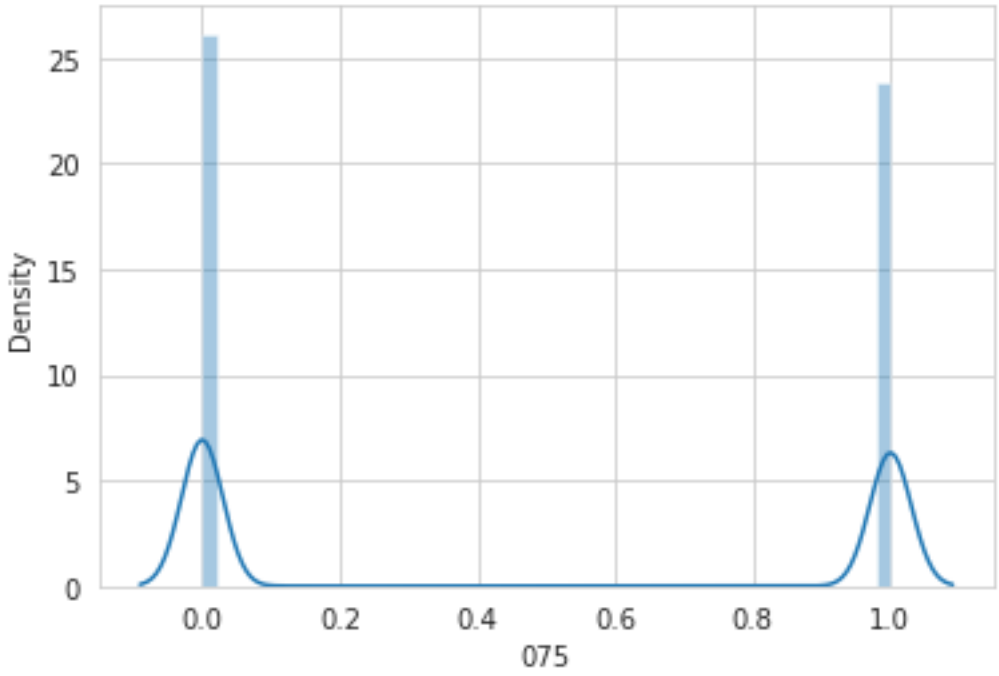
[153]:
```
alpha = 75
```

[154]:
```
%%time
alphas[f'{alpha:03}'] = alpha075(l, v, vwap)
```

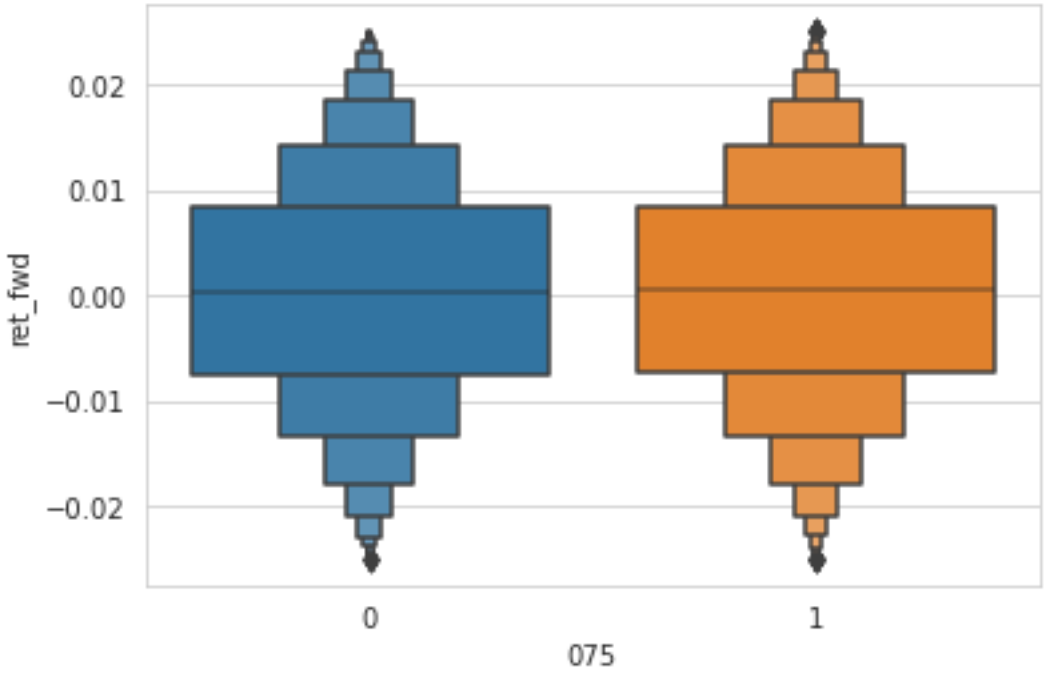
```
CPU times: user 4.79 s, sys: 36 ms, total: 4.83 s
Wall time: 4.76 s
```

[155]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[156]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[157]:
```
g = sns.boxenplot(x=f'{alpha:03}', y='ret_fwd', data=alphas[alphas.ret_fwd.
↪between(-.025, .025)]);
```



[158]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[158]:

075	count	mean	std	min	25%	50%	75%	max
0	656508.0	0.000545	0.026144	-0.757755	-0.009674	0.000472	0.010631	2.317073
1	598585.0	0.000621	0.025328	-0.607908	-0.009625	0.000529	0.010706	0.814423

1.80 Alpha 076

(rank(ts_delta(IndNeutralize(((close * 0.60733) + (open * (1 - 0.60733))),IndClass.sector), 1.
rank(ts_corr(Ts_Rank(vwap, 3.60973), Ts_Rank(adv150,9.18637), 14.6644)))

[159]:
```
def alpha076(l, vwap, sector):
    """(max(rank(ts_weighted_mean(ts_delta(vwap, 1.24383), 11.8259)),
```

```
            ts_rank(ts_weighted_mean(ts_rank(ts_corr(IndNeutralize(low,␣
↪IndClass.sector), adv81,8.14941), 19.569), 17.1543), 19.383)) * -1)
    """
    pass
```

[160]:
```
alpha = 76
```

1.81 Alpha 077

```
min(rank(ts_weighted_mean(((((high + low) / 2) + high) - (vwap + high)), 20.0451)),
            rank(ts_weighted_mean(ts_corr(((high + low) / 2), adv40, 3.1614), 5.64125)))
```

[161]:
```
def alpha077(l, h, vwap):
    """min(rank(ts_weighted_mean(((((high + low) / 2) + high) - (vwap + high)),␣
↪20.0451)),
            rank(ts_weighted_mean(ts_corr(((high + low) / 2), adv40, 3.1614), 5.
↪64125)))
    """

    s1 = rank(ts_weighted_mean(h.add(l).div(2).sub(vwap), 20))
    s2 = rank(ts_weighted_mean(ts_corr(h.add(l).div(2), ts_mean(v, 40), 3), 5))
    return (s1.where(s1 < s2, s2)
            .stack('ticker')
            .swaplevel())
```

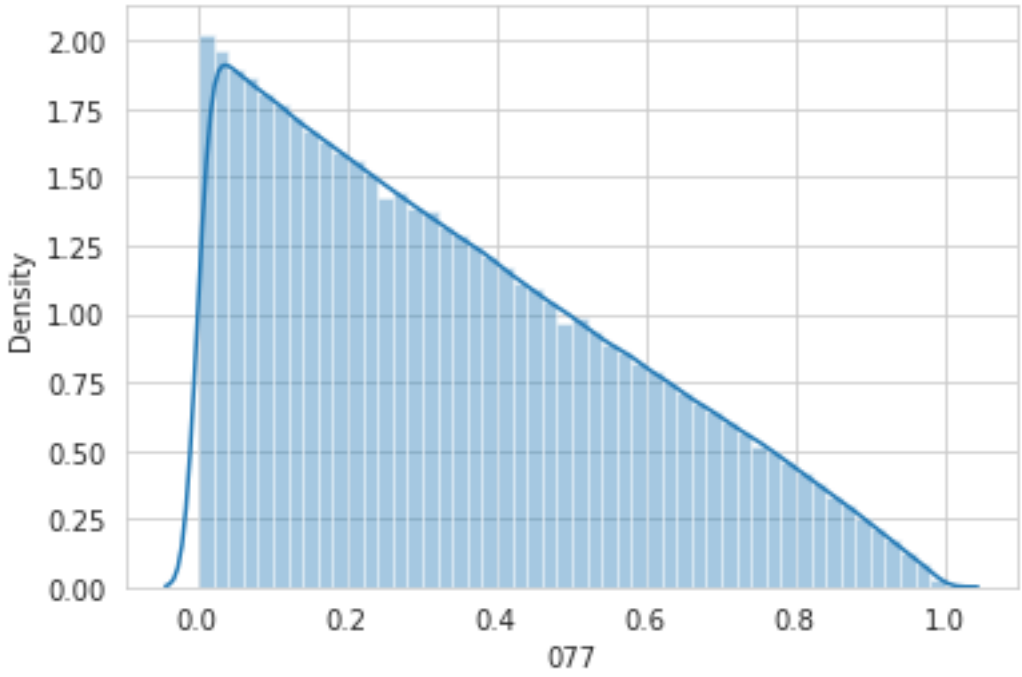
[162]:
```
alpha = 77
```

[163]:
```
%%time
alphas[f'{alpha:03}'] = alpha077(l, h, vwap)
```

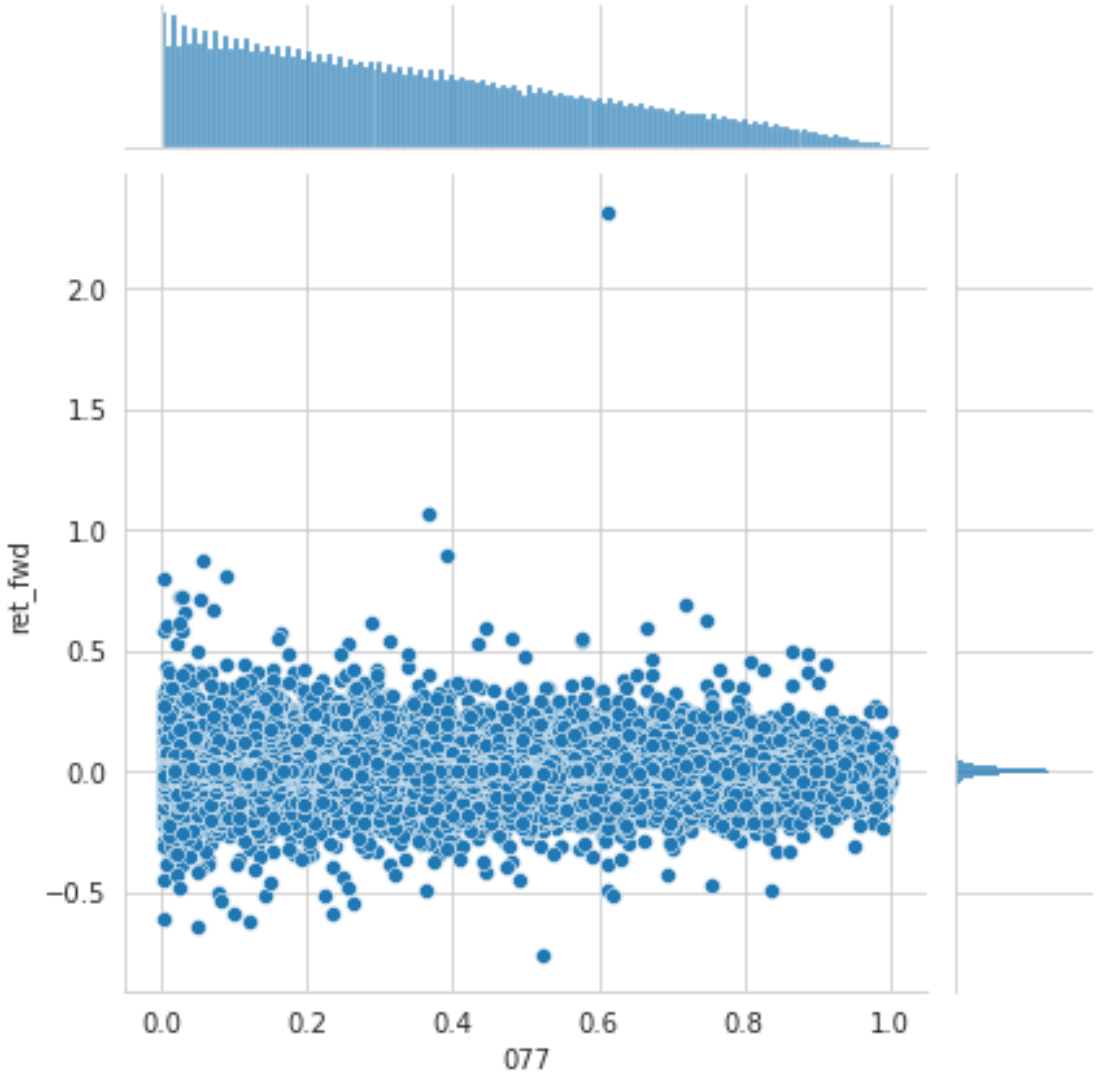
```
CPU times: user 3.73 s, sys: 16 ms, total: 3.75 s
Wall time: 3.66 s
```

[164]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[165]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[166]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[167]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[167]: 0

1.82 Alpha 078

(rank(ts_corr(ts_sum(((low * 0.352233) + (vwap * (1 - 0.352233))), 19.7428),
ts_sum(adv40, 19.7428), 6.83313))^rank(ts_corr(rank(vwap), rank(volume), 5.77492)))

[168]:
```
def alpha078(l, v, vwap):
    """(rank(ts_corr(ts_sum(((low * 0.352233) + (vwap * (1 - 0.352233))), 19.
↪7428),
```

```
        ts_sum(adv40, 19.7428), 6.83313))^rank(ts_corr(rank(vwap),␣
↪rank(volume), 5.77492)))"""

    w = 0.352233
    return (rank(ts_corr(ts_sum((l.mul(w).add(vwap.mul(1 - w))), 19),
                         ts_sum(ts_mean(v, 40), 19), 6))
            .pow(rank(ts_corr(rank(vwap), rank(v), 5)))
            .stack('ticker')
            .swaplevel())
```

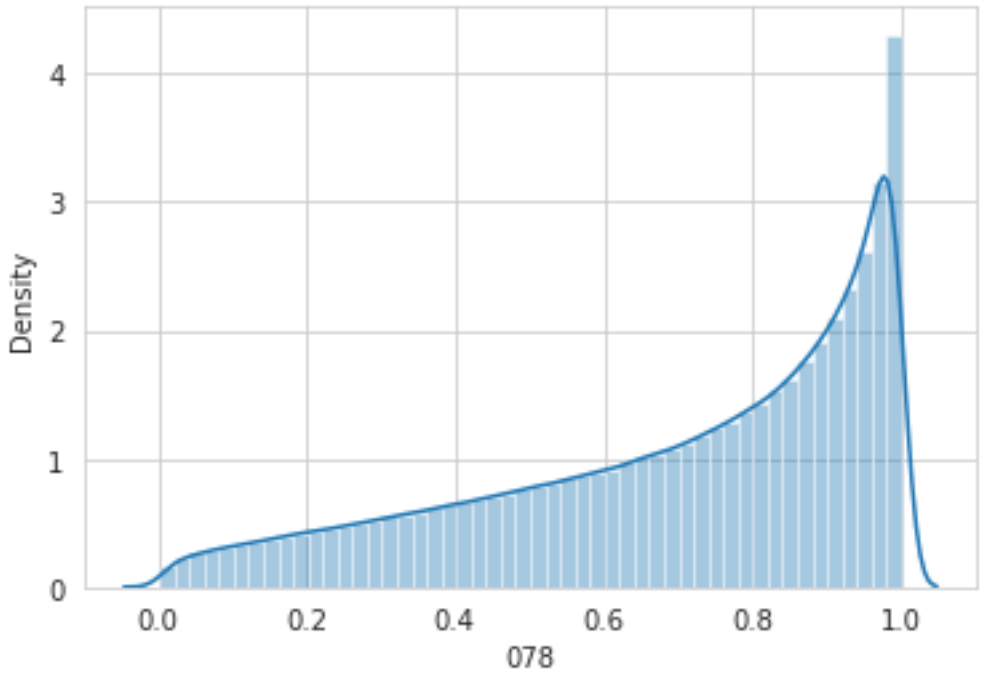
[169]:
```
alpha = 78
```

[170]:
```
%%time
alphas[f'{alpha:03}'] = alpha078(l, v, vwap)
```

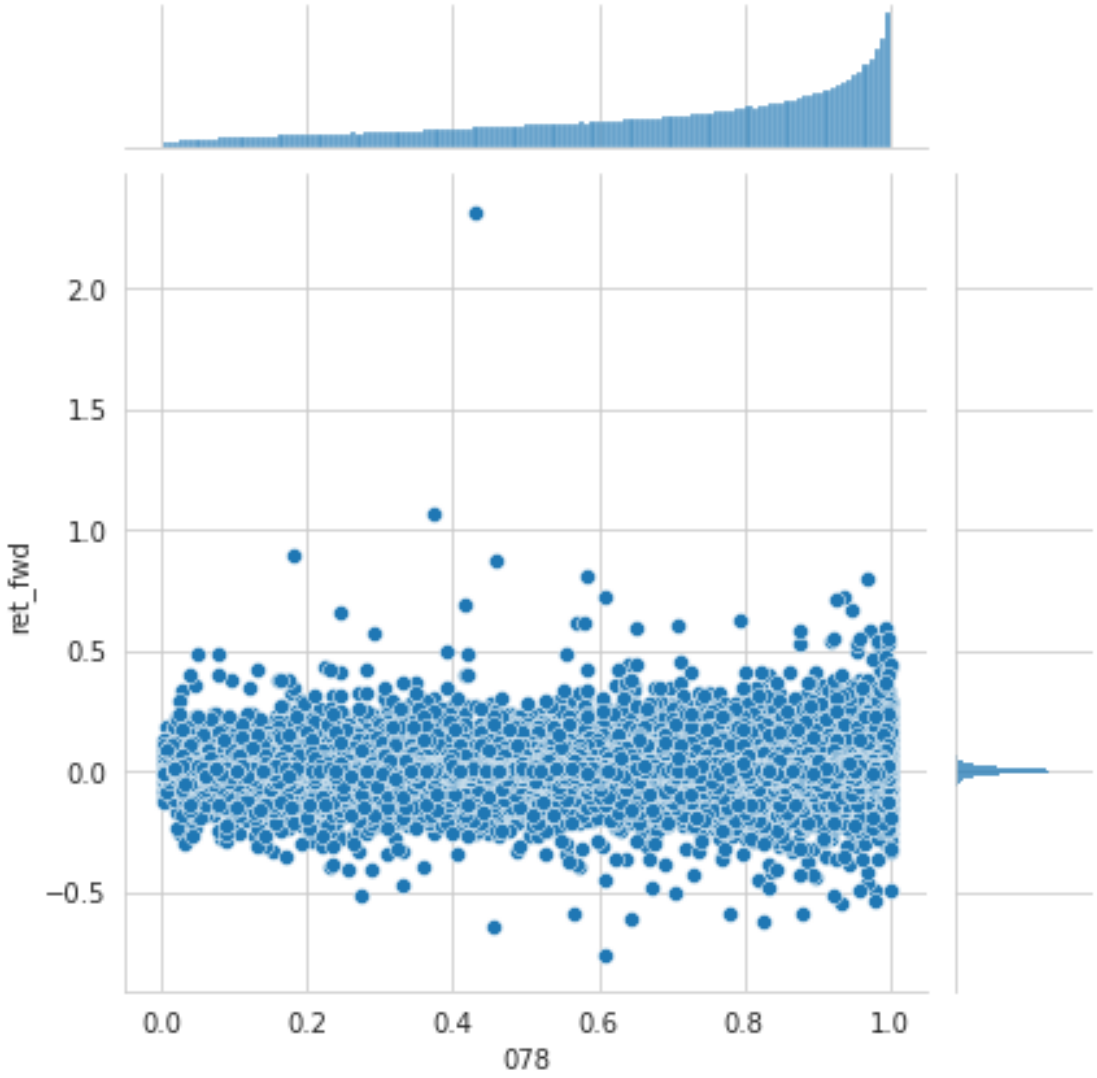
```
CPU times: user 4.67 s, sys: 20 ms, total: 4.69 s
Wall time: 4.59 s
```

[171]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[172]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[173]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[174]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[174]: 0.0002397436931129704

1.83 Alpha 079

```
(rank(ts_delta(IndNeutralize(((close * 0.60733) + (open * (1 - 0.60733))),IndClass.sector), 1.1
       rank(ts_corr(Ts_Rank(vwap, 3.60973), Ts_Rank(adv150,9.18637), 14.6644)))
```

[175]:
```
def alpha079(o, v, sector):
    """(rank(ts_delta(IndNeutralize(((close * 0.60733) + (open * (1 - 0.
↪60733))),IndClass.sector), 1.23438)) <
       rank(ts_corr(Ts_Rank(vwap, 3.60973), Ts_Rank(adv150,9.18637), 14.6644)))
```

```
    """
    pass
```

1.84 Alpha 080

```
((power(rank(sign(ts_delta(IndNeutralize(((open * 0.868128) + (high * (1 - 0.868128))),IndClass
        ts_rank(ts_corr(high, adv10, 5.11456), 5.53756)) * -1)
```

[176]:
```
def alpha080(h, industry):
    """((power(rank(sign(ts_delta(IndNeutralize(((open * 0.868128) + (high * (1␣
↪- 0.868128))),IndClass.industry), 4.04545))),
        ts_rank(ts_corr(high, adv10, 5.11456), 5.53756)) * -1)
    """
    pass
```

1.85 Alpha 081

```
-(rank(log(ts_product(rank((rank(ts_corr(vwap, ts_sum(adv10, 49.6054),8.47743))^4)), 14.9655)))
        rank(ts_corr(rank(vwap), rank(volume), 5.07914)))
```

[177]:
```
def alpha081(v, vwap):
    """-(rank(log(ts_product(rank((rank(ts_corr(vwap, ts_sum(adv10, 49.6054),8.
↪47743))^4)), 14.9655))) <
        rank(ts_corr(rank(vwap), rank(volume), 5.07914)))"""

    return (rank(log(ts_product(rank(rank(ts_corr(vwap,
                                                  ts_sum(ts_mean(v, 10), 50),␣
↪8))
                                     .pow(4)), 15)))
            .lt(rank(ts_corr(rank(vwap), rank(v), 5)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

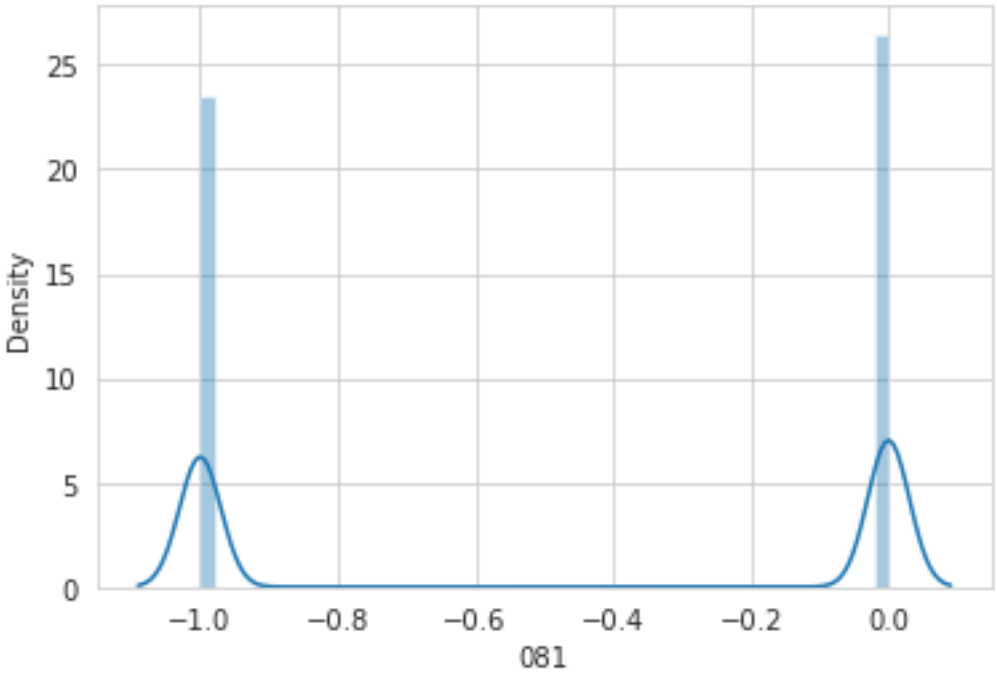
[178]:
```
alpha = 81
```

[179]:
```
%%time
alphas[f'{alpha:03}'] = alpha081(v, vwap)
```

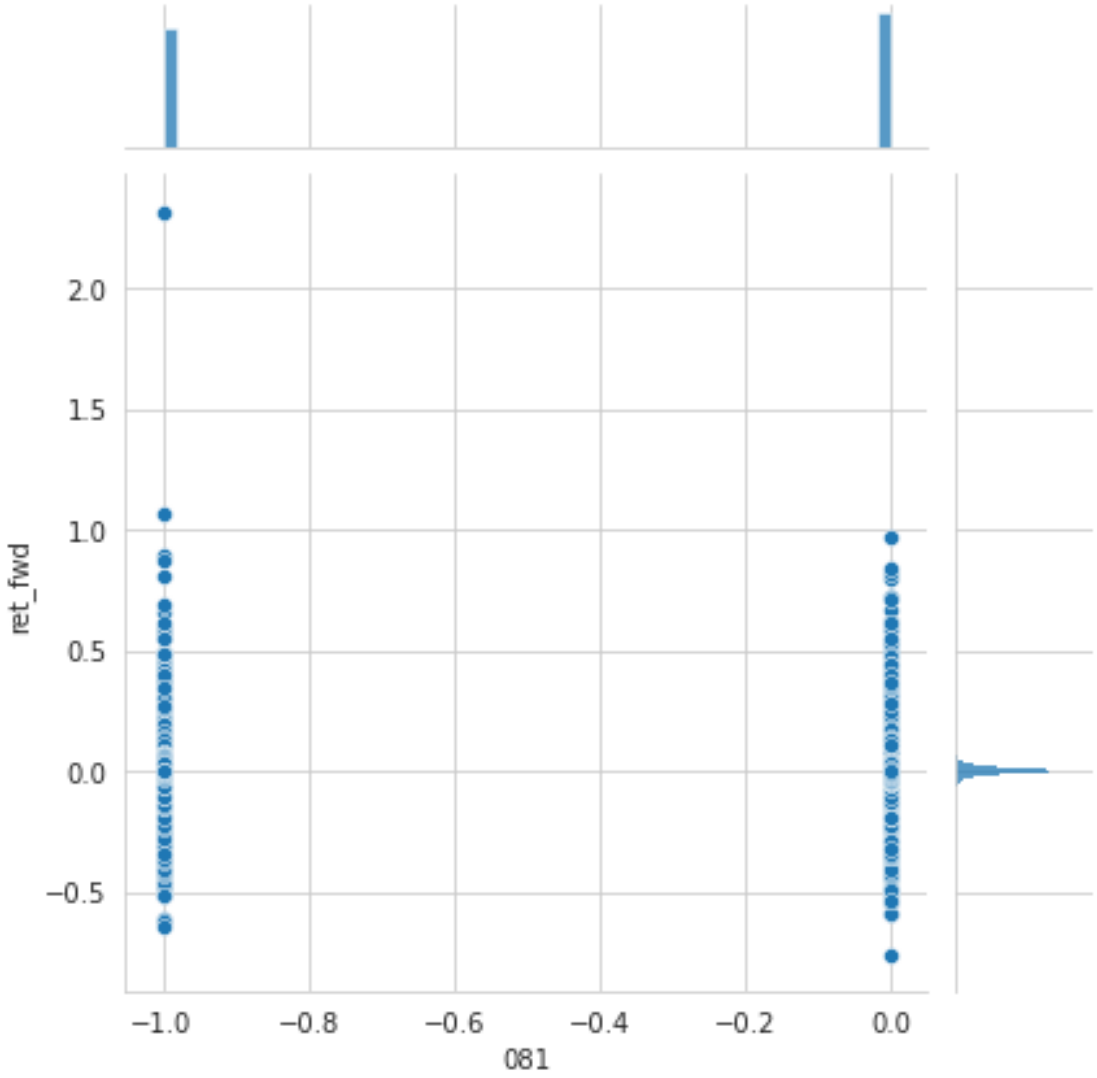
```
CPU times: user 1min 57s, sys: 593 ms, total: 1min 57s
Wall time: 1min 57s
```

[180]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[181]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[182]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[183]:
```
# mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
# mi[alpha]
```

1.86 Alpha 082

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
       rank((returns * cap))
```

[184]:
```
def alpha082(o, v, sector):
    """(min(rank(ts_weighted_mean(ts_delta(open, 1.46063), 14.8717)),
        ts_rank(ts_weighted_mean(ts_corr(IndNeutralize(volume, IndClass.
↪sector),
        ((open * 0.634196) +(open * (1 - 0.634196))), 17.4842), 6.92131), 13.
↪4283)) * -1)
```

```
    """
    pass
```

1.87 Alpha 083

```
(rank(ts_lag((high - low) / ts_mean(close, 5), 2)) * rank(rank(volume)) /
    (((high - low) / ts_mean(close, 5) / (vwap - close)))
```

[185]:
```
def alpha083(h, l, c):
    """(rank(ts_lag((high - low) / ts_mean(close, 5), 2)) * rank(rank(volume)) /
 ↪
            (((high - low) / ts_mean(close, 5) / (vwap - close)))
    """
    s = h.sub(l).div(ts_mean(c, 5))

    return (rank(rank(ts_lag(s, 2))
                 .mul(rank(rank(v)))
                 .div(s).div(vwap.sub(c).add(1e-3)))
            .stack('ticker')
            .swaplevel()
            .replace((np.inf, -np.inf), np.nan))
```

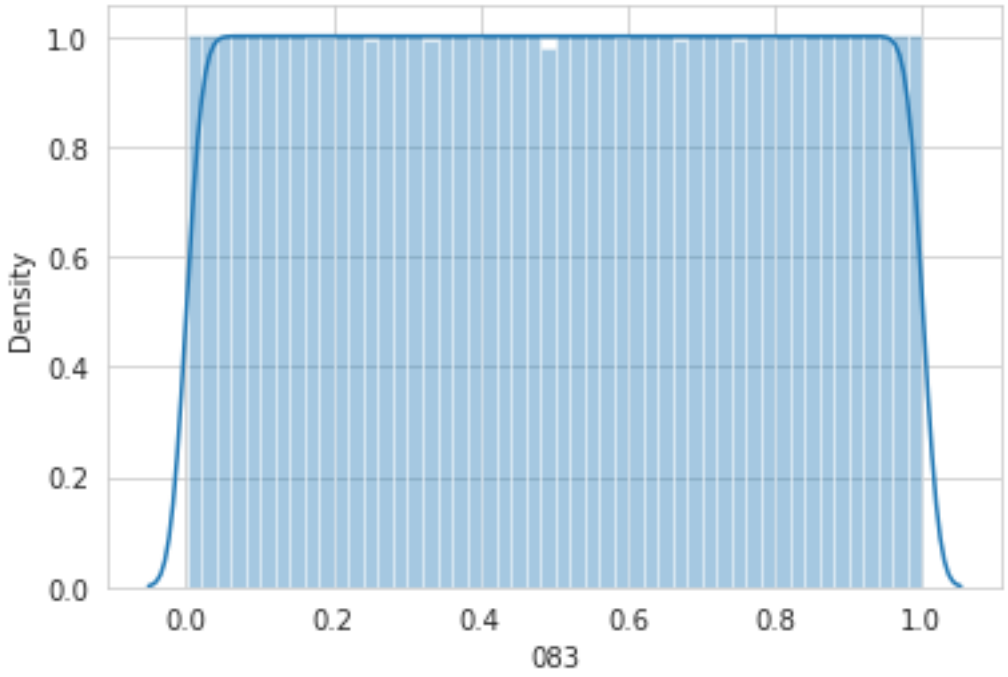
[186]:
```
alpha = 83
```

[187]:
```
%%time
alphas[f'{alpha:03}'] = alpha083(h, l, c)
```

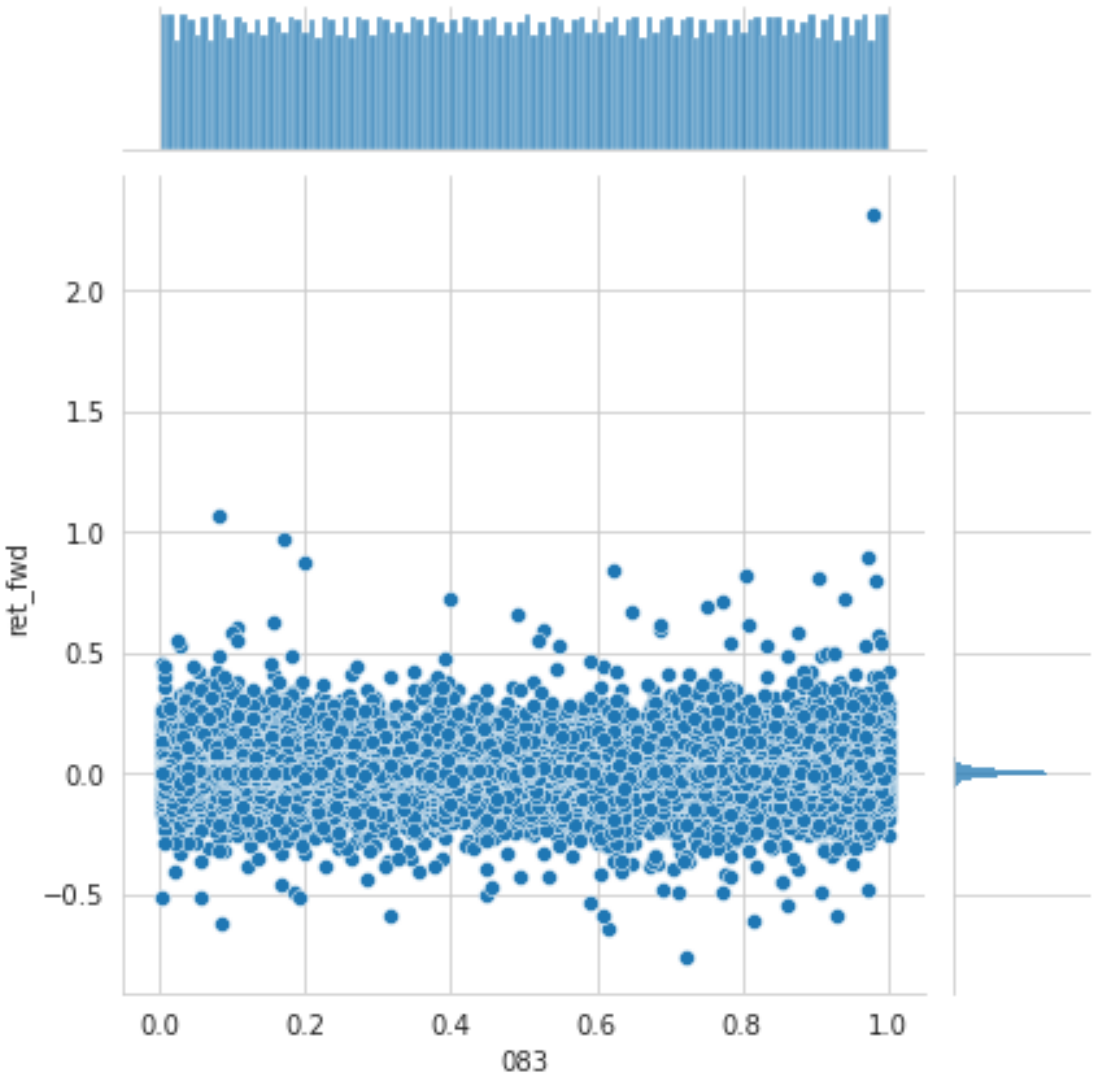
```
CPU times: user 2.8 s, sys: 16 ms, total: 2.81 s
Wall time: 2.75 s
```

[188]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[189]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[190]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[191]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[191]: 0.0005100117425032025

1.88 Alpha 084

```
power(ts_rank((vwap - ts_max(vwap, 15.3217)), 20.7127),
           ts_delta(close,4.96796))
```

[192]:
```
def alpha084(c, vwap):
    """power(ts_rank((vwap - ts_max(vwap, 15.3217)), 20.7127),
        ts_delta(close,4.96796))"""
    return (rank(power(ts_rank(vwap.sub(ts_max(vwap, 15)), 20),
```

```
                        ts_delta(c, 6)))
            .stack('ticker')
            .swaplevel())
```

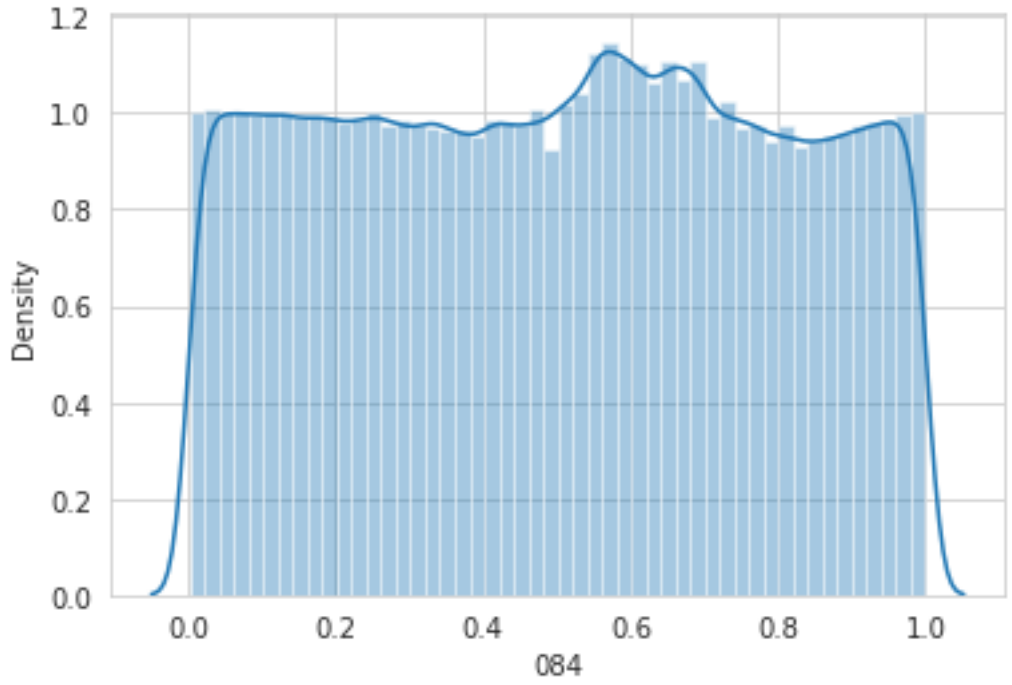
[193]:
```
alpha = 84
```

[194]:
```
%%time
alphas[f'{alpha:03}'] = alpha084(c, vwap)
```

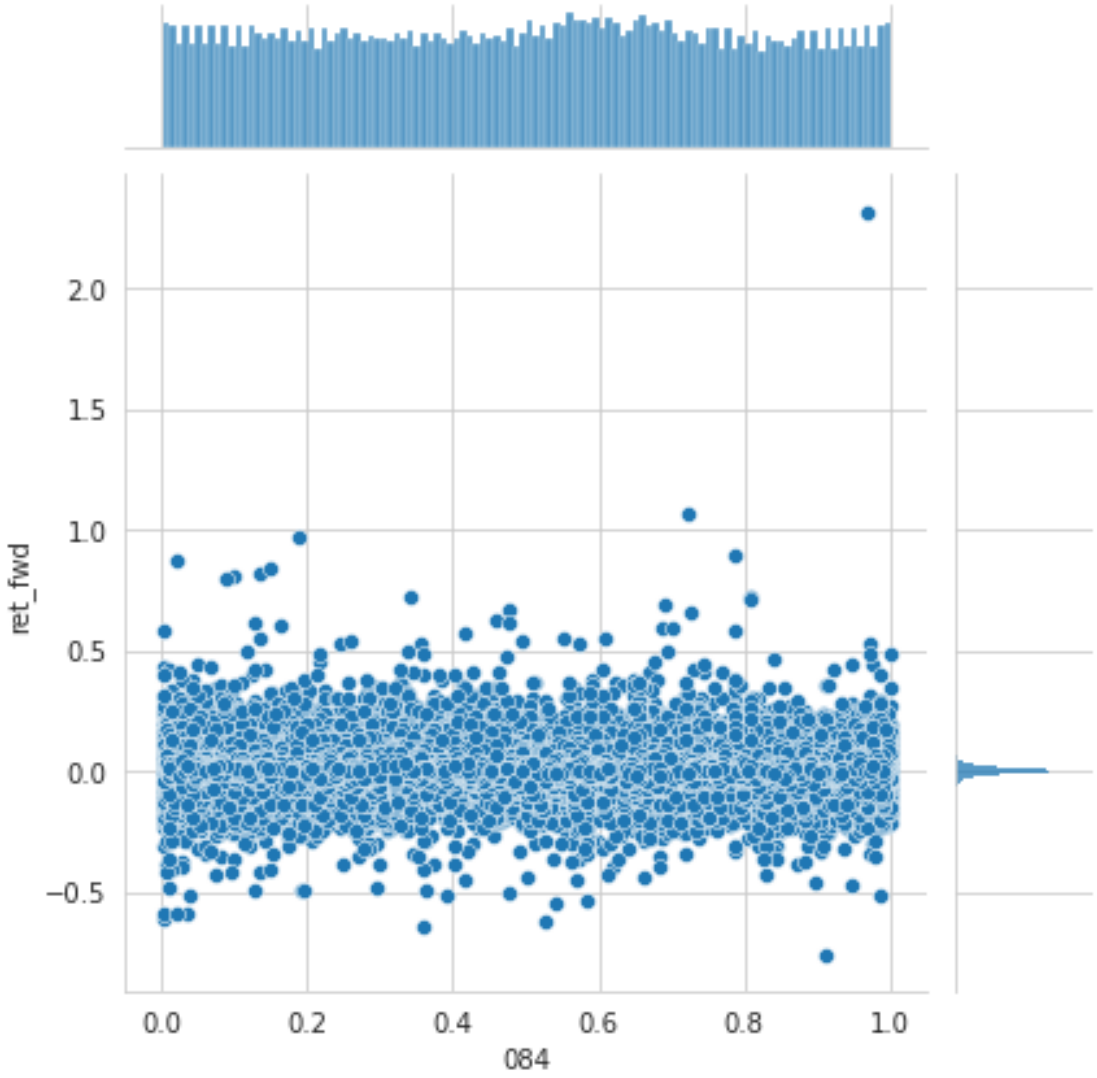
```
CPU times: user 3min 2s, sys: 47.7 ms, total: 3min 2s
Wall time: 3min 2s
```

[195]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[196]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[197]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[198]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[198]: 0.008688359695486092

1.89 Alpha 085

```
power(rank(ts_corr(((high * 0.876703) + (close * (1 - 0.876703))), adv30,9.61331)),
        rank(ts_corr(ts_rank(((high + low) / 2), 3.70596),
                     ts_rank(volume, 10.1595),7.11408)))
```

[199]:
```
def alpha085(l, v):
    """power(rank(ts_corr(((high * 0.876703) + (close * (1 - 0.876703))),␣
 ↪adv30,9.61331)),
```

```
        rank(ts_corr(ts_rank(((high + low) / 2), 3.70596),
                     ts_rank(volume, 10.1595),7.11408)))
                     """
    w = 0.876703
    return (rank(ts_corr(h.mul(w).add(c.mul(1 - w)), ts_mean(v, 30), 10))
            .pow(rank(ts_corr(ts_rank(h.add(l).div(2), 4),
                              ts_rank(v, 10), 7)))
            .stack('ticker')
            .swaplevel())
```

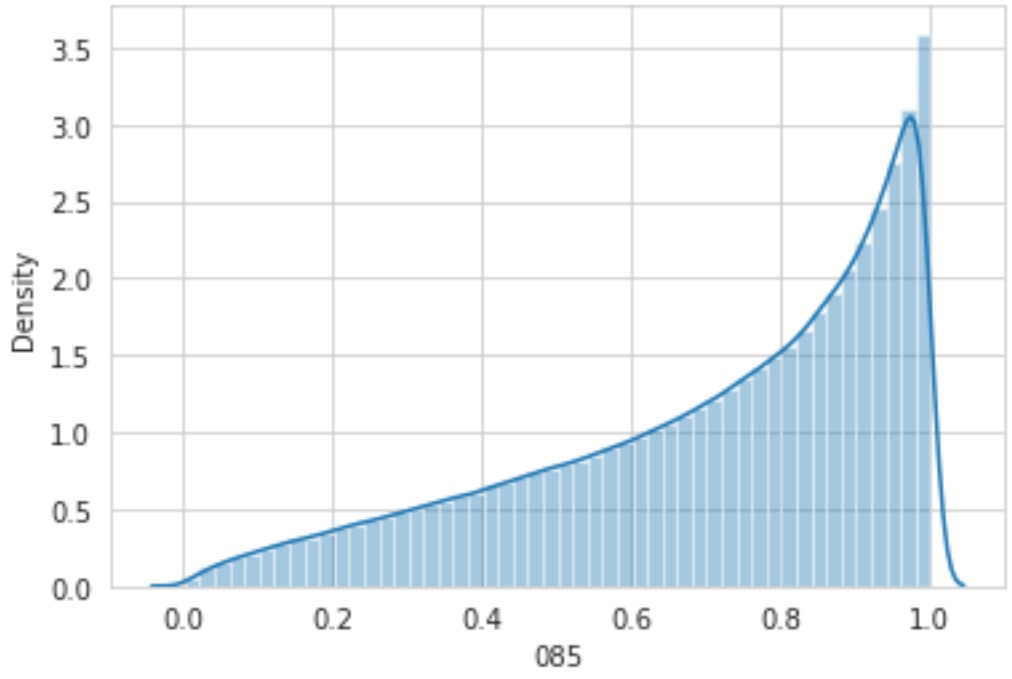
[200]:
```
alpha = 85
```

[201]:
```
%%time
alphas[f'{alpha:03}'] = alpha085(l, v)
```

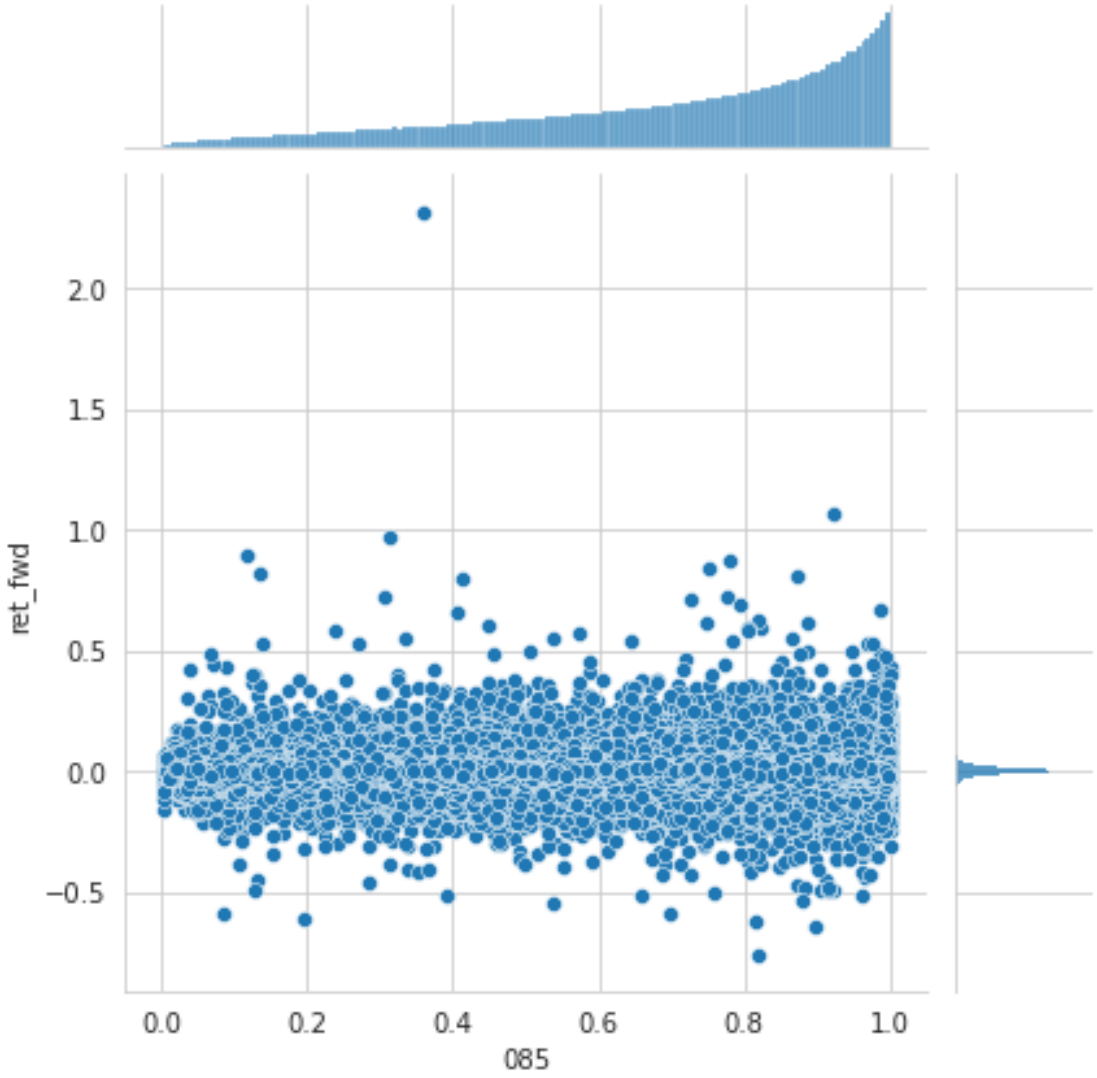
```
CPU times: user 6min 14s, sys: 123 ms, total: 6min 14s
Wall time: 6min 14s
```

[202]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[203]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[204]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[205]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[205]:
```
0.001101338196749957
```

1.90 Alpha 086

```
((ts_rank(ts_corr(close, ts_sum(adv20, 14.7444), 6.00049), 20.4195) <
       rank(((open + close) - (vwap + open)))) * -1)
```

[206]:
```
def alpha086(c, v, vwap):
    """((ts_rank(ts_corr(close, ts_sum(adv20, 14.7444), 6.00049), 20.4195) <
        rank(((open + close) - (vwap + open)))) * -1)
    """
```

```
    return (ts_rank(ts_corr(c, ts_mean(ts_mean(v, 20), 15), 6), 20)
            .lt(rank(c.sub(vwap)))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

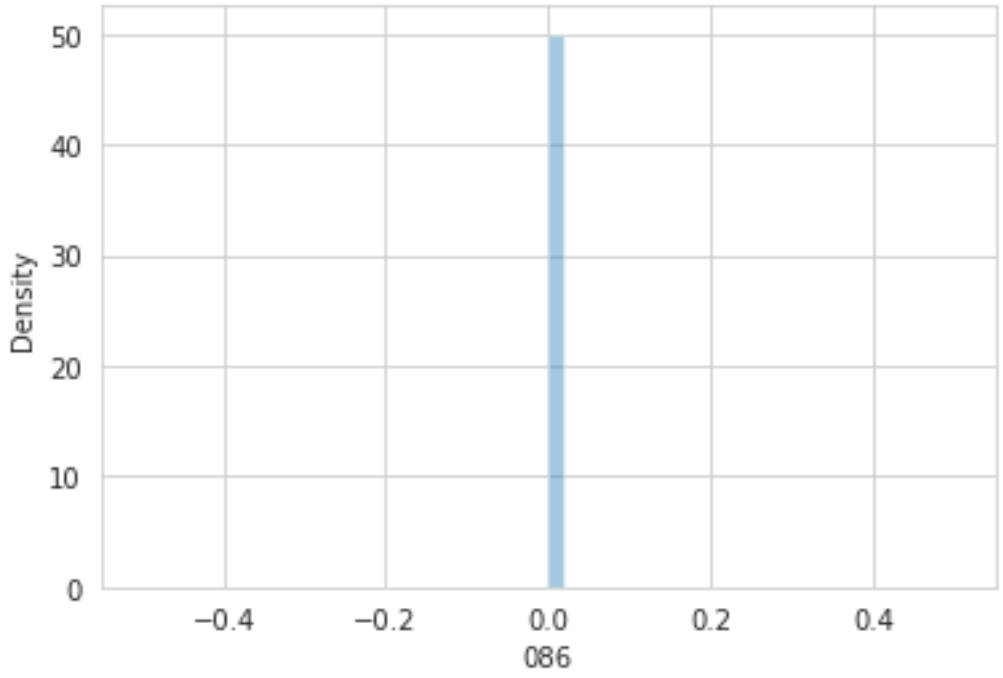
[207]:
```
alpha = 86
```

[208]:
```
%%time
alphas[f'{alpha:03}'] = alpha086(c, v, vwap)
```

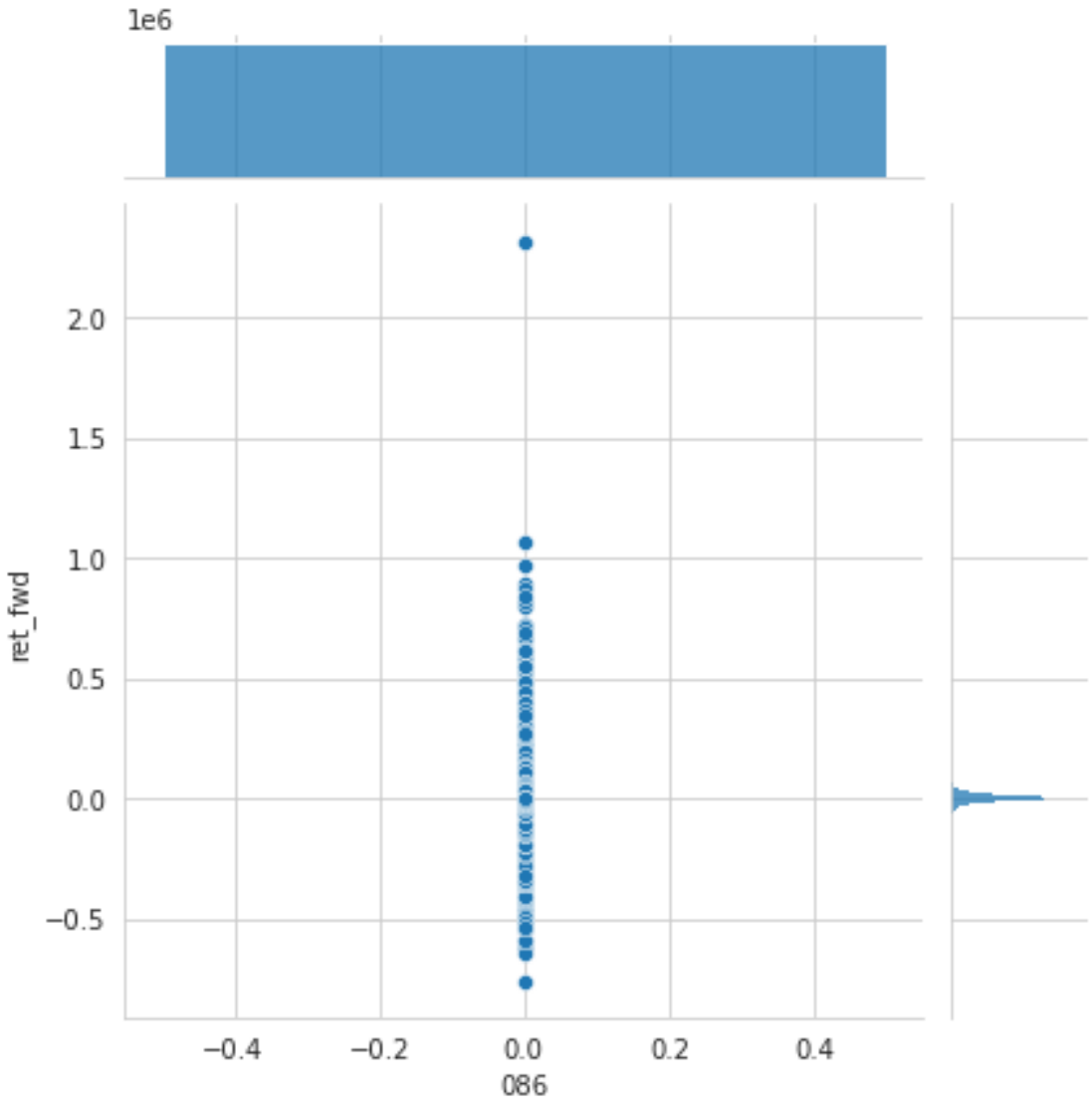
```
CPU times: user 3min 2s, sys: 152 ms, total: 3min 2s
Wall time: 3min 2s
```

[209]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[210]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[211]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[212]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[212]: 0.00020642450841457105

1.91 Alpha 087

```
(max(rank(ts_weighted_mean(ts_delta(((close * 0.369701) + (vwap * (1 -
0.369701))),1.91233), 2.65461)),              ts_rank(ts_weighted_mean(abs(ts_corr(IndNeutrali
close, 13.4132)), 4.89768), 14.4535)) * -1)
```

[213]:

```
def alpha087(c, vwap, industry):
    """(max(rank(ts_weighted_mean(ts_delta(((close * 0.369701) + (vwap * (1 - 0.
↪369701))),1.91233), 2.65461)),
            ts_rank(ts_weighted_mean(abs(ts_corr(IndNeutralize(adv81,IndClass.
↪industry), close, 13.4132)), 4.89768), 14.4535)) * -1)
    """
    pass
```

1.92 Alpha 088

```
min(rank(ts_weighted_mean(((rank(open) + rank(low)) - (rank(high) + rank(close))),8.06882)),
        ts_rank(ts_weighted_mean(ts_corr(ts_rank(close, 8.44728),
                ts_rank(adv60,20.6966), 8.01266), 6.65053), 2.61957))
```

[214]:
```
def alpha088(o, h, l, c, v):
    """min(rank(ts_weighted_mean(((rank(open) + rank(low)) - (rank(high) +␣
↪rank(close))),8.06882)),
        ts_rank(ts_weighted_mean(ts_corr(ts_rank(close, 8.44728),
                ts_rank(adv60,20.6966), 8.01266), 6.65053), 2.61957))"""

    s1 = (rank(ts_weighted_mean(rank(o)
                                .add(rank(l))
                                .sub(rank(h))
                                .add(rank(c)), 8)))
    s2 = ts_rank(ts_weighted_mean(ts_corr(ts_rank(c, 8),
                                          ts_rank(ts_mean(v, 60), 20), 8), 6),␣
↪2)

    return (s1.where(s1 < s2, s2)
            .stack('ticker')
            .swaplevel())
```

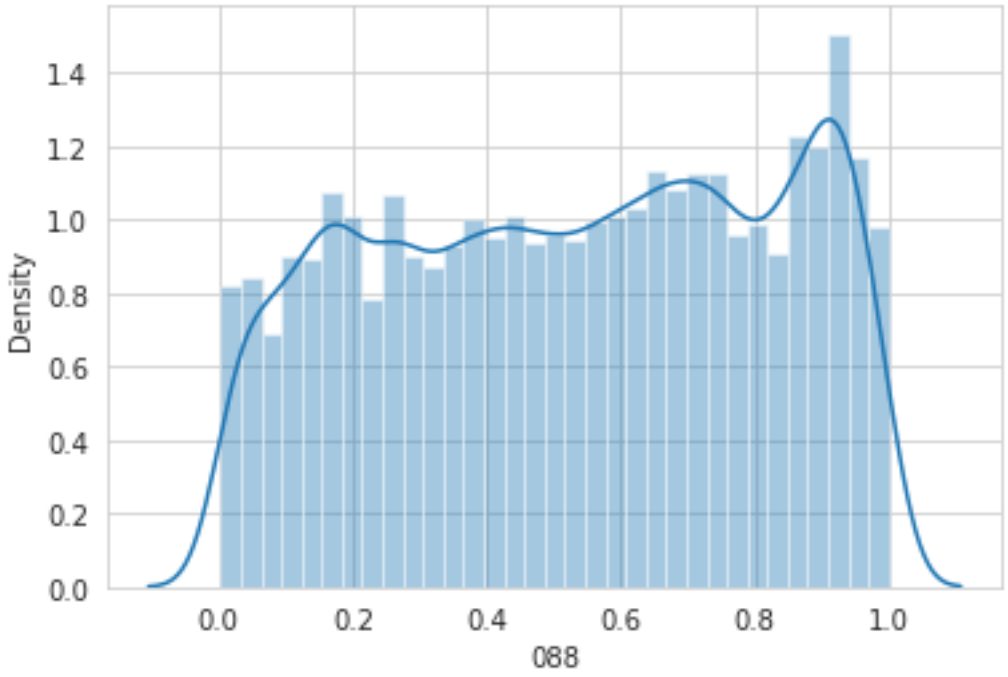
[215]:
```
alpha = 88
```

[216]:
```
%%time
alphas[f'{alpha:03}'] = alpha088(o, h, l, c, v)
```

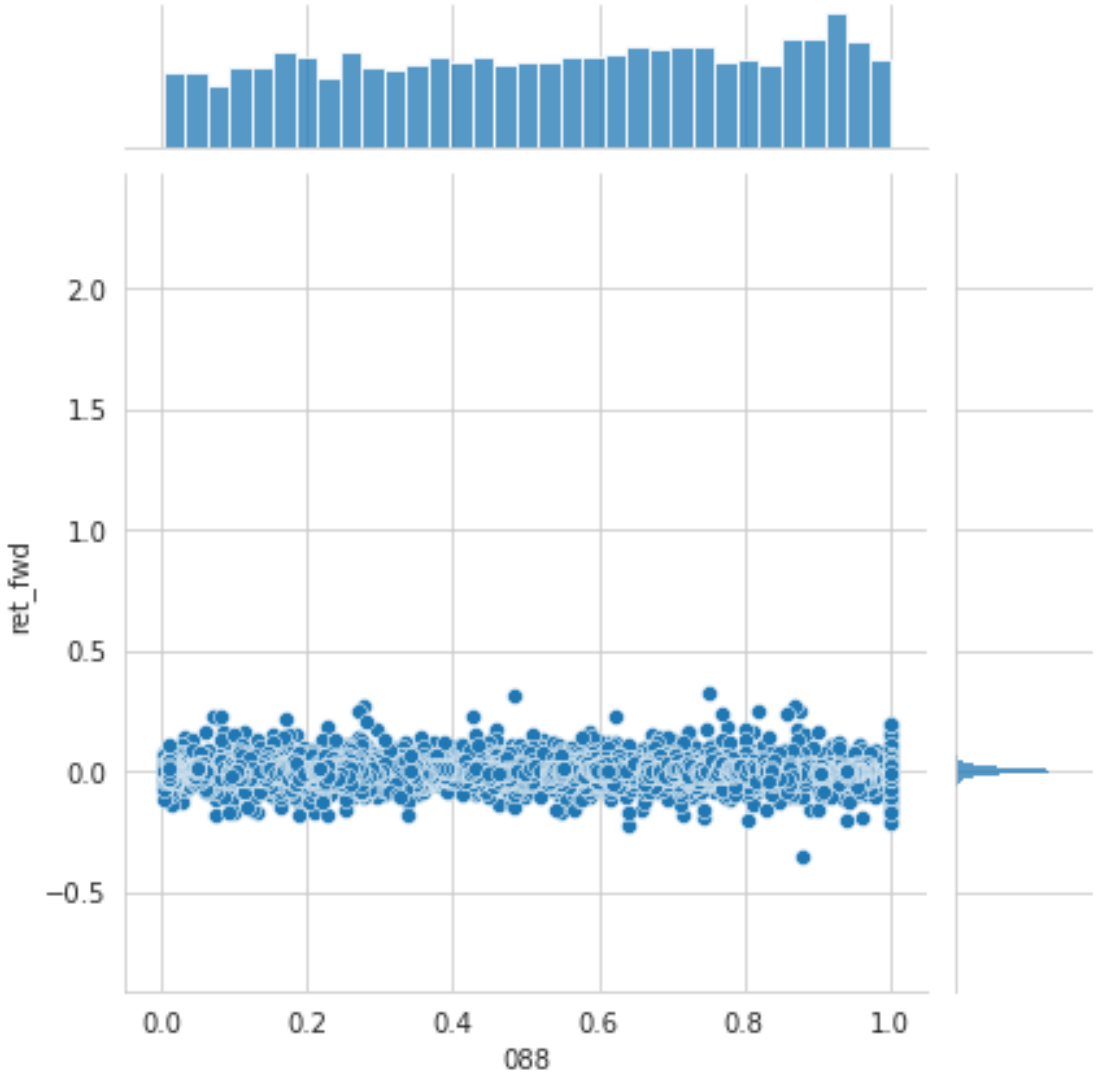
```
CPU times: user 6min 7s, sys: 79.6 ms, total: 6min 7s
Wall time: 6min 7s
```

[217]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[218]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[219]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[220]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'],␣
↪n=30000)
mi[alpha]
```

[220]: 0.019146991360432075

1.93 Alpha 089

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
       rank((returns * cap))
```

[221]:
```
def alpha089(l, v, vwap, industry):
    """(ts_rank(ts_weighted_mean(ts_corr(((low * 0.967285) +
        (low * (1 - 0.967285))), adv10,6.94279), 5.51607), 3.79744) -
```

```
        ts_rank(ts_weighted_mean(ts_delta(IndNeutralize(vwap,IndClass.
↪industry), 3.48158), 10.1466), 15.3012))
    """
    pass
```

1.94 Alpha 090

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
        rank((returns * cap))
```

[222]:
```
def alpha090(c, l, subindustry):
    """((rank((close - ts_max(close, 4.66719)))
        ^ts_rank(ts_corr(IndNeutralize(adv40,IndClass.subindustry), low, 5.
↪38375), 3.21856)) * -1)
    """
    pass
```

1.95 Alpha 091

```
((ts_rank(ts_weighted_mean(ts_weighted_mean(ts_corr(IndNeutralize(close,IndClass.industry), vo
        rank(ts_weighted_mean(ts_corr(vwap, adv30, 4.01303), 2.6809))) * -1)
```

[223]:
```
def alpha091(v, vwap, industry):
    ␣
↪"""((ts_rank(ts_weighted_mean(ts_weighted_mean(ts_corr(IndNeutralize(close,IndClass.
↪industry), volume, 9.74928), 16.398), 3.83219), 4.8667) -
        rank(ts_weighted_mean(ts_corr(vwap, adv30, 4.01303), 2.6809))) * -1)
    """
    pass
```

1.96 Alpha 092

```
min(ts_rank(ts_weighted_mean(((((high + low) / 2) + close) < (low + open)), 14.7221),18.8683),
            ts_rank(ts_weighted_mean(ts_corr(rank(low), rank(adv30), 7.58555), 6.94024),6.8058
```

[224]:
```
def alpha092(o, l, c, v):
    """min(ts_rank(ts_weighted_mean(((((high + low) / 2) + close) < (low +␣
↪open)), 14.7221),18.8683),
            ts_rank(ts_weighted_mean(ts_corr(rank(low), rank(adv30), 7.58555),␣
↪6.94024),6.80584))
    """
    p1 = ts_rank(ts_weighted_mean(h.add(l).div(2).add(c).lt(l.add(o)), 15), 18)
    p2 = ts_rank(ts_weighted_mean(ts_corr(rank(l), rank(ts_mean(v, 30)), 7),␣
↪6), 6)

    return (p1.where(p1<p2, p2)
            .stack('ticker')
```

```
            .swaplevel())
```

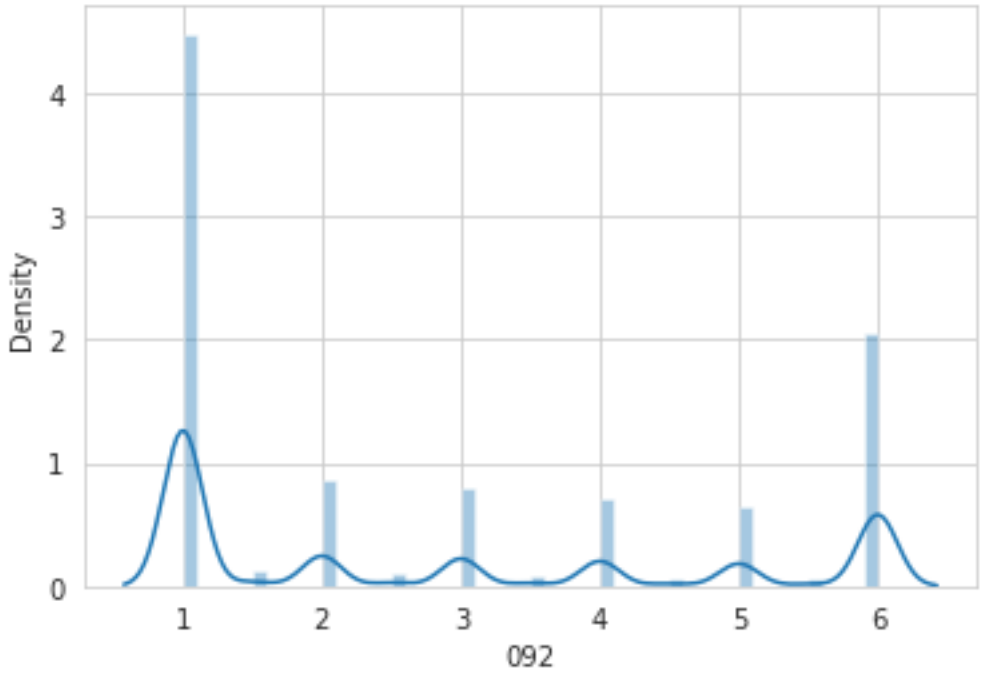
[225]:
```
alpha = 92
```

[226]:
```
%%time
alphas[f'{alpha:03}'] = alpha092(o, l, c, v)
```

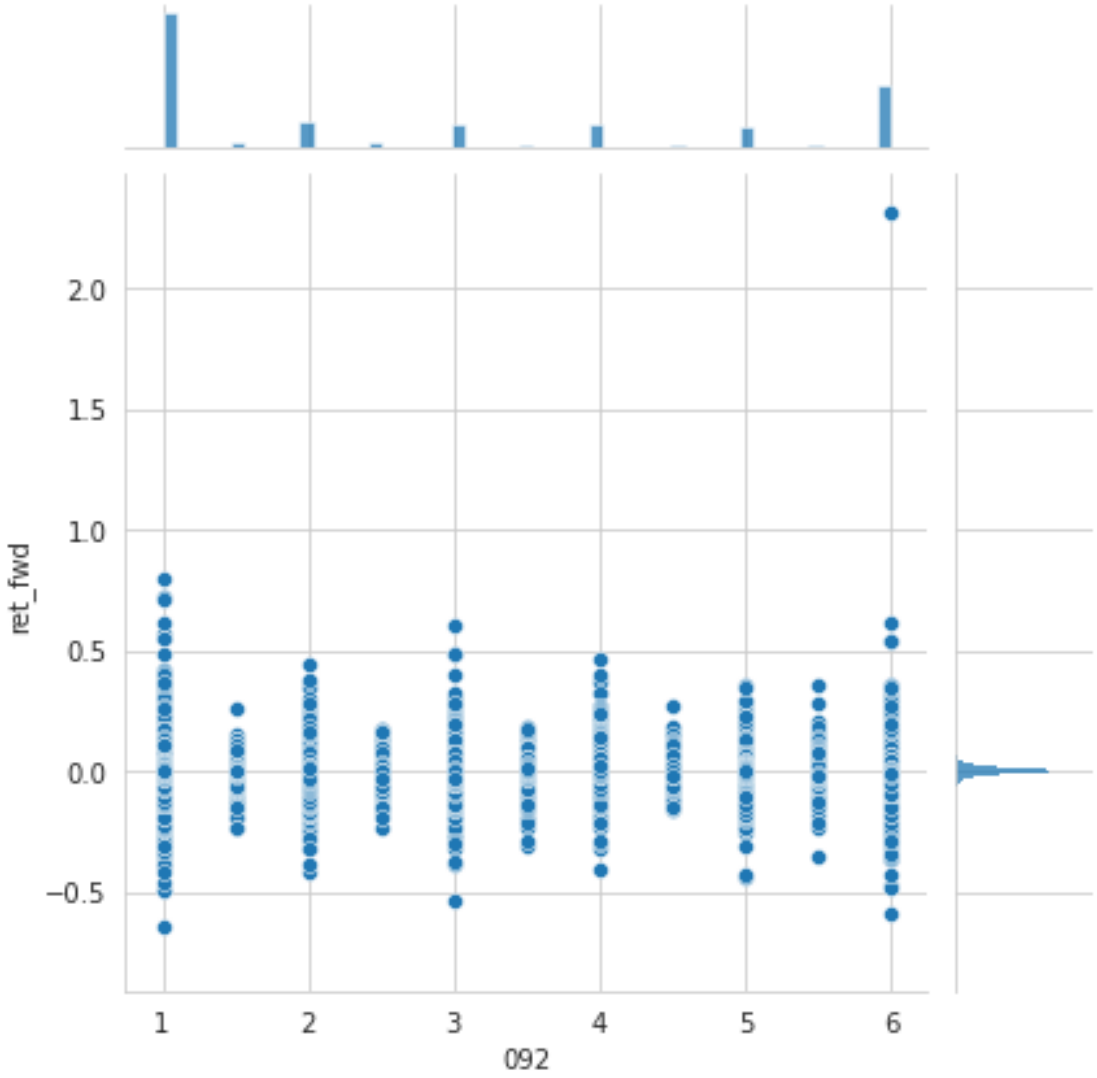
```
CPU times: user 4min 33s, sys: 39.8 ms, total: 4min 34s
Wall time: 4min 33s
```

[227]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[228]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[229]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[230]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[230]: 0.0034230030791526644

1.97 Alpha 093

```
(ts_rank(ts_weighted_mean(ts_corr(IndNeutralize(vwap, IndClass.industry), adv81,17.4193), 19.84
       rank(ts_weighted_mean(ts_delta(((close * 0.524434) + (vwap * (1 -0.524434))), 2.77377)
```

[231]:
```
def alpha093(c, v, vwap, industry):
    """(ts_rank(ts_weighted_mean(ts_corr(IndNeutralize(vwap, IndClass.
↪industry), adv81,17.4193), 19.848), 7.54455) /
```

```
        rank(ts_weighted_mean(ts_delta(((close * 0.524434) + (vwap * (1 -0.
↪524434))), 2.77377), 16.2664)))
    """
    pass
```

1.98 Alpha 094

```
((rank((vwap - ts_min(vwap, 11.5783)))^ts_rank(ts_corr(ts_rank(vwap,19.6462),
        ts_rank(adv60, 4.02992), 18.0926), 2.70756)) * -1)
```

[232]:
```
def alpha094(v, vwap):
    """((rank((vwap - ts_min(vwap, 11.5783)))^ts_rank(ts_corr(ts_rank(vwap,19.
↪6462),
        ts_rank(adv60, 4.02992), 18.0926), 2.70756)) * -1)
    """

    return (rank(vwap.sub(ts_min(vwap, 11)))
            .pow(ts_rank(ts_corr(ts_rank(vwap, 20),
                                 ts_rank(ts_mean(v, 60), 4), 18), 2))
            .mul(-1)
            .stack('ticker')
            .swaplevel())
```

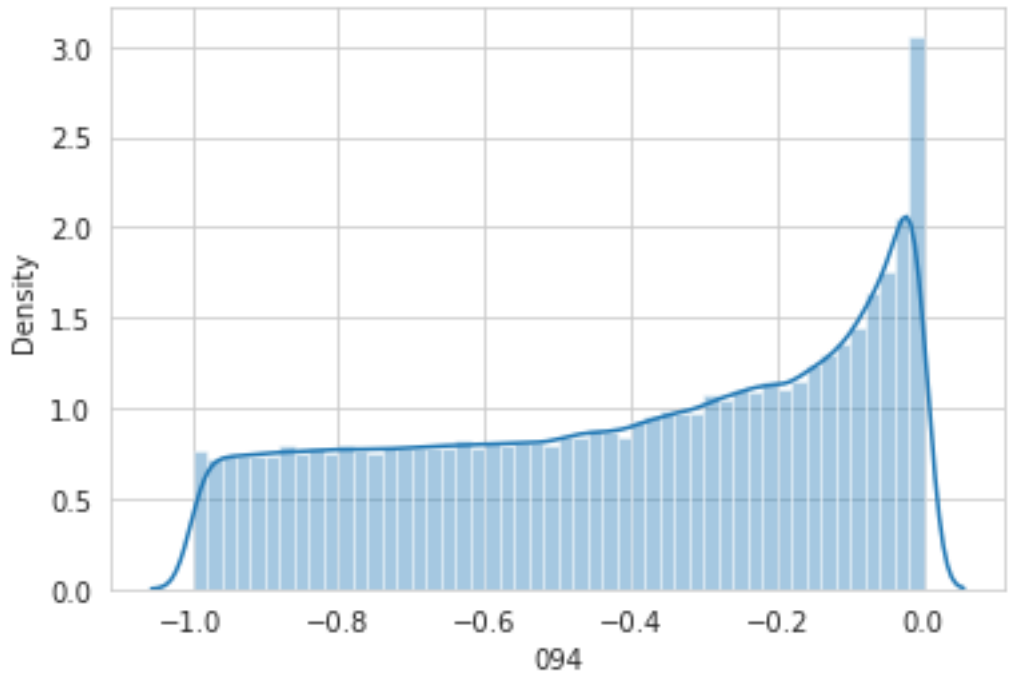
[233]:
```
alpha = 94
```

[234]:
```
%%time
alphas[f'{alpha:03}'] = alpha094(v, vwap)
```

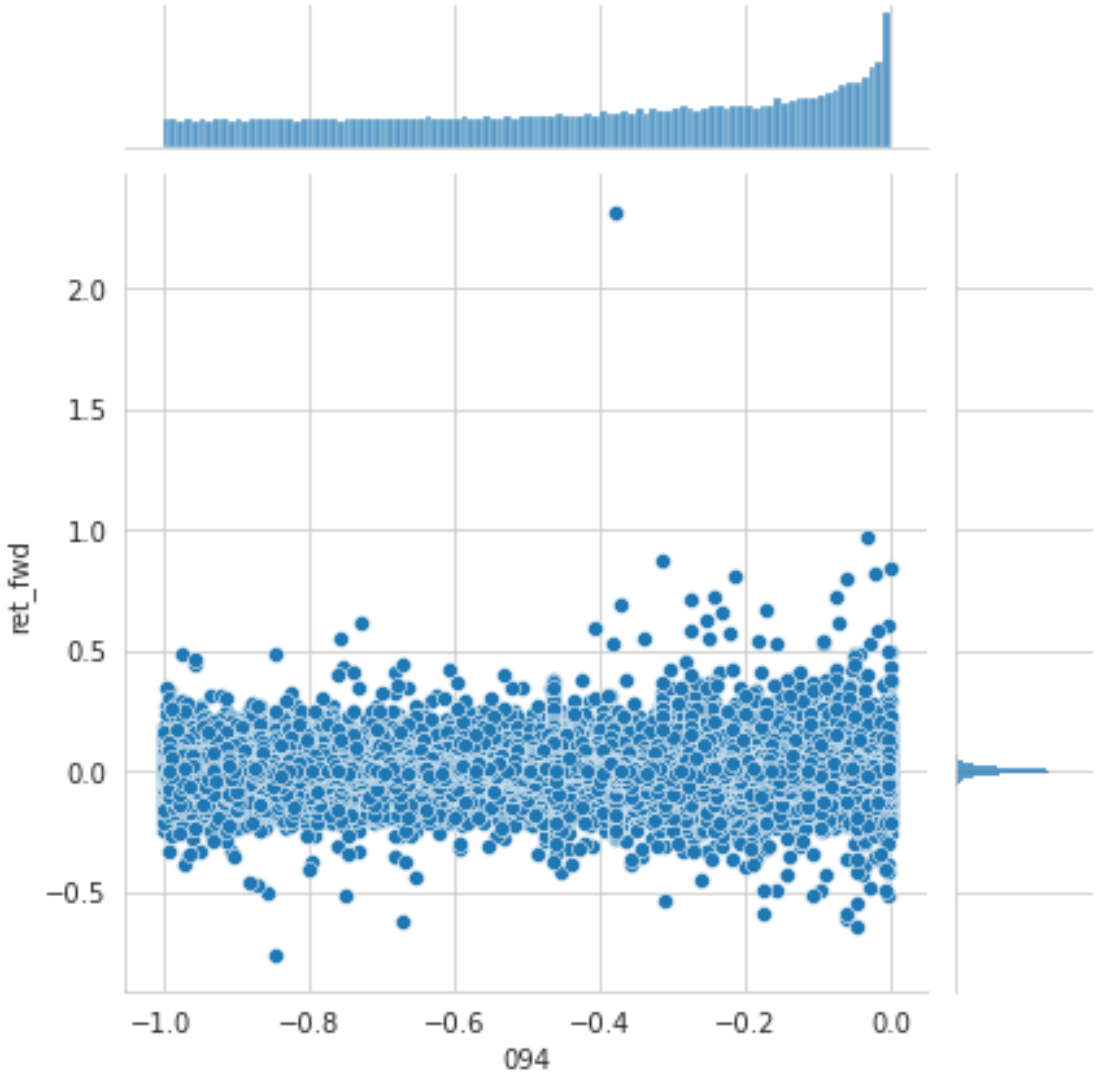
```
CPU times: user 8min 59s, sys: 164 ms, total: 8min 59s
Wall time: 9min
```

[235]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[236]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[237]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[238]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[238]: 0.005173119205998944

1.99 Alpha 095

```
(rank((open - ts_min(open, 12.4105))) <
    ts_rank((rank(ts_corr(ts_sum(((high + low)/ 2), 19.1351),
    ts_sum(adv40, 19.1351), 12.8742))^5), 11.7584))
```

[239]:
```
def alpha095(o, l, v):
    """(rank((open - ts_min(open, 12.4105))) <
```

```
        ts_rank((rank(ts_corr(ts_sum(((high + low)/ 2), 19.1351), ts_sum(adv40,␣
↪19.1351), 12.8742))~5), 11.7584))
    """

    return (rank(o.sub(ts_min(o, 12)))
            .lt(ts_rank(rank(ts_corr(ts_mean(h.add(l).div(2), 19),
                                     ts_sum(ts_mean(v, 40), 19), 13).pow(5)),␣
↪12))
            .astype(int)
            .stack('ticker')
            .swaplevel())
```

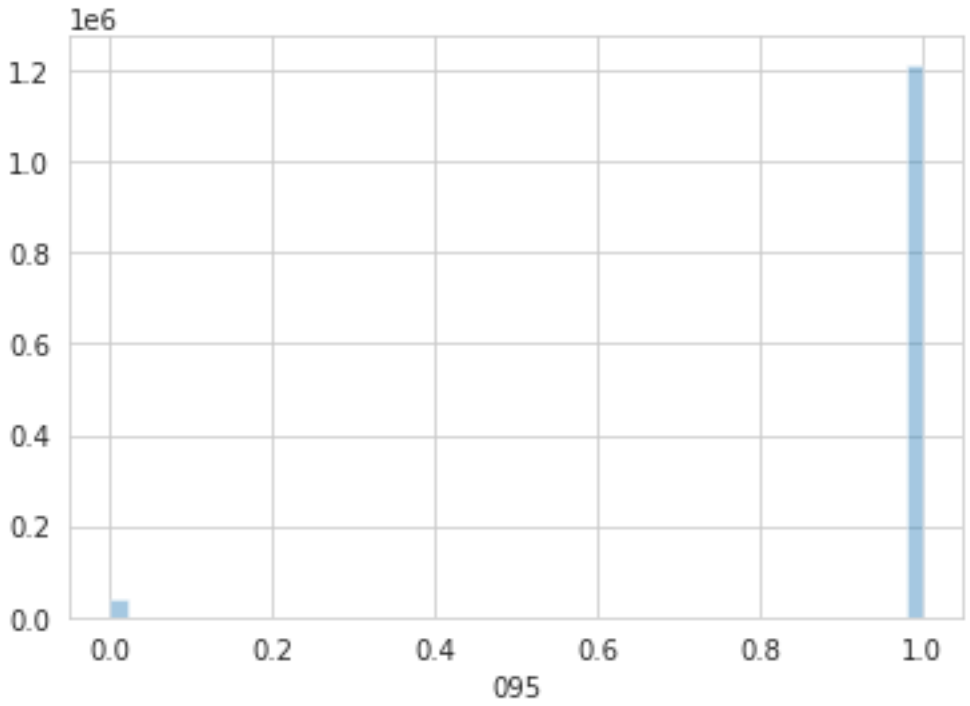
[240]:
```
alpha = 95
```

[241]:
```
%%time
alphas[f'{alpha:03}'] = alpha095(o, l, v)
```

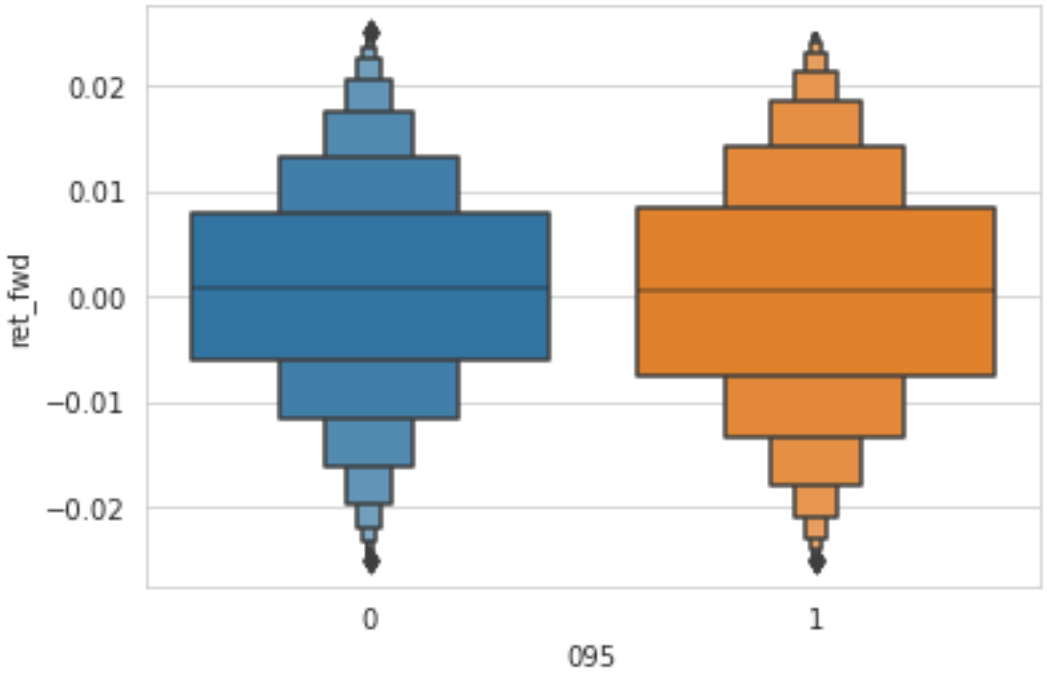
```
CPU times: user 3min 3s, sys: 43.9 ms, total: 3min 3s
Wall time: 3min 3s
```

[242]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[243]:
```
sns.distplot(alphas[f'{alpha:03}'], kde=False);
```



[244]:
```
g = sns.boxenplot(x=f'{alpha:03}', y='ret_fwd', data=alphas[alphas.ret_fwd.
↪between(-.025, .025)]);
```



[245]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[245]:

095	count	mean	std	min	25%	50%	75%	max
0	42212.0	0.001107	0.018945	-0.441048	-0.006959	0.000900	0.008912	0.500000
1	1212881.0	0.000563	0.025963	-0.757755	-0.009764	0.000481	0.010736	2.317073

1.100 Alpha 096

(max(ts_rank(ts_weighted_mean(ts_corr(rank(vwap), rank(volume), 5.83878),4.16783), 8.38151),
ts_rank(ts_weighted_mean(ts_argmax(ts_corr(ts_rank(close, 7.45404), ts_rank(adv60, 4.13

[246]:
```
def alpha096(c, v, vwap):
    """(max(ts_rank(ts_weighted_mean(ts_corr(rank(vwap), rank(volume), 5.
↪83878),4.16783), 8.38151),
        ts_rank(ts_weighted_mean(ts_argmax(ts_corr(ts_rank(close, 7.45404),␣
↪ts_rank(adv60, 4.13242), 3.65459), 12.6556), 14.0365), 13.4143)) * -1)"""
```

```
    s1 = ts_rank(ts_weighted_mean(ts_corr(rank(vwap), rank(v), 10), 4), 8)
    s2 = ts_rank(ts_weighted_mean(ts_argmax(ts_corr(ts_rank(c, 7),
                                                    ts_rank(ts_mean(v, 60),␣
↪10), 10), 12), 14), 13)
    return (s1.where(s1 > s2, s2)
              .mul(-1)
              .stack('ticker')
              .swaplevel())
```

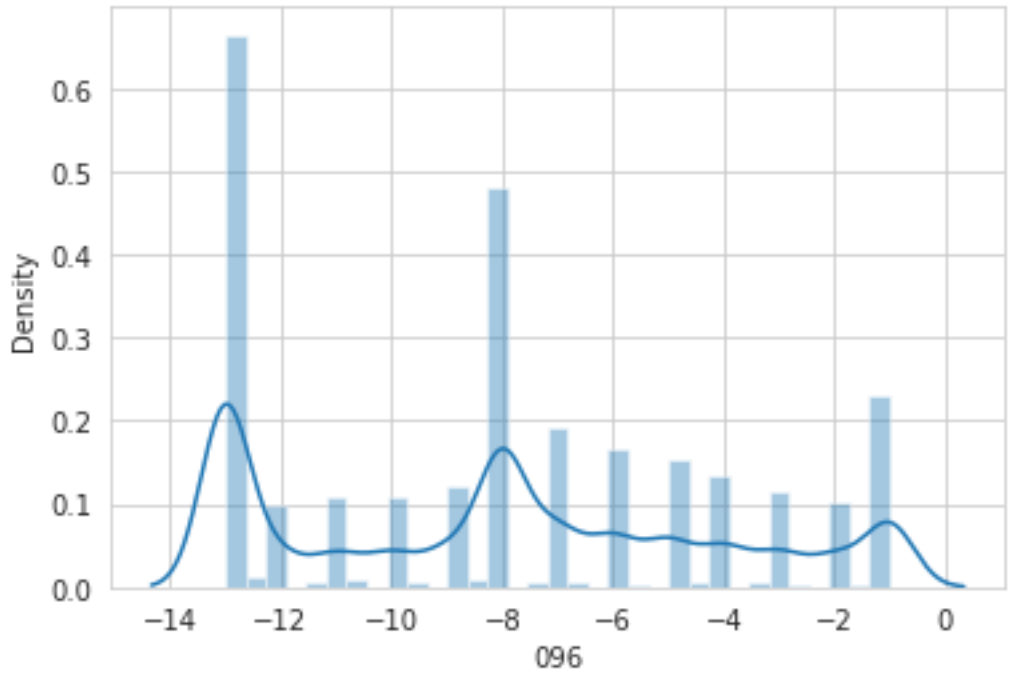
[247]:
```
alpha = 96
```

[248]:
```
%%time
alphas[f'{alpha:03}'] = alpha096(c, v, vwap)
```

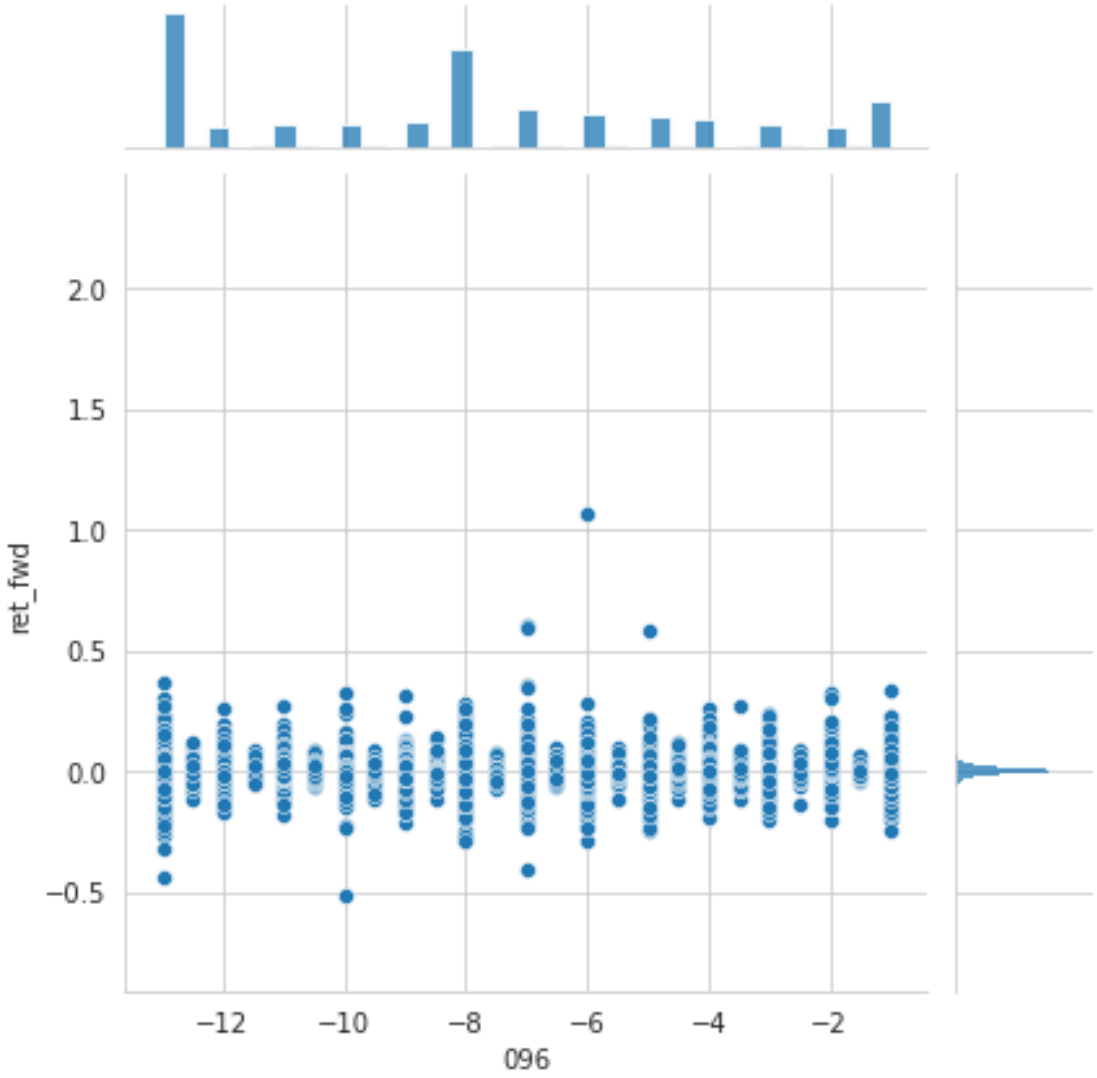
```
CPU times: user 10min 4s, sys: 432 ms, total: 10min 4s
Wall time: 10min 6s
```

[249]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[250]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[251]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas)
```



1.101 Alpha 097

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
       rank((returns * cap))
```

[253]:
```
def alpha097(l):
    """((rank(ts_weighted_mean(ts_delta(IndNeutralize(((low * 0.721001) +
        (vwap * (1 - 0.721001))),IndClass.industry), 3.3705), 20.4523)) -
        ts_rank(ts_weighted_mean(ts_rank(ts_corr(Ts_Rank(low,7.87871),
        ts_rank(adv60, 17.255), 4.97547), 18.5925), 15.7152), 6.71659)) * -1)
    """
    pass
```

1.102 Alpha 098

```
(rank(ts_weighted_mean(ts_corr(vwap, ts_sum(adv5, 26.4719), 4.58418), 7.18088)) -
        rank(ts_weighted_mean(ts_tank(ts_argmin(ts_corr(rank(open),
        rank(adv15), 20.8187), 8.62571),6.95668), 8.07206)))
```

[254]:
```
def alpha098(o, v, vwap):
    """(rank(ts_weighted_mean(ts_corr(vwap, ts_sum(adv5, 26.4719), 4.58418), 7.
 ↪18088)) -
        rank(ts_weighted_mean(ts_tank(ts_argmin(ts_corr(rank(open),
        rank(adv15), 20.8187), 8.62571),6.95668), 8.07206)))
    """
    adv5 = ts_mean(v, 5)
    adv15 = ts_mean(v, 15)
    return (rank(ts_weighted_mean(ts_corr(vwap, ts_mean(adv5, 26), 4), 7))
            .sub(rank(ts_weighted_mean(ts_rank(ts_argmin(ts_corr(rank(o),
                                                                 rank(adv15),␣
 ↪20), 8), 6))))
            .stack('ticker')
            .swaplevel())
```

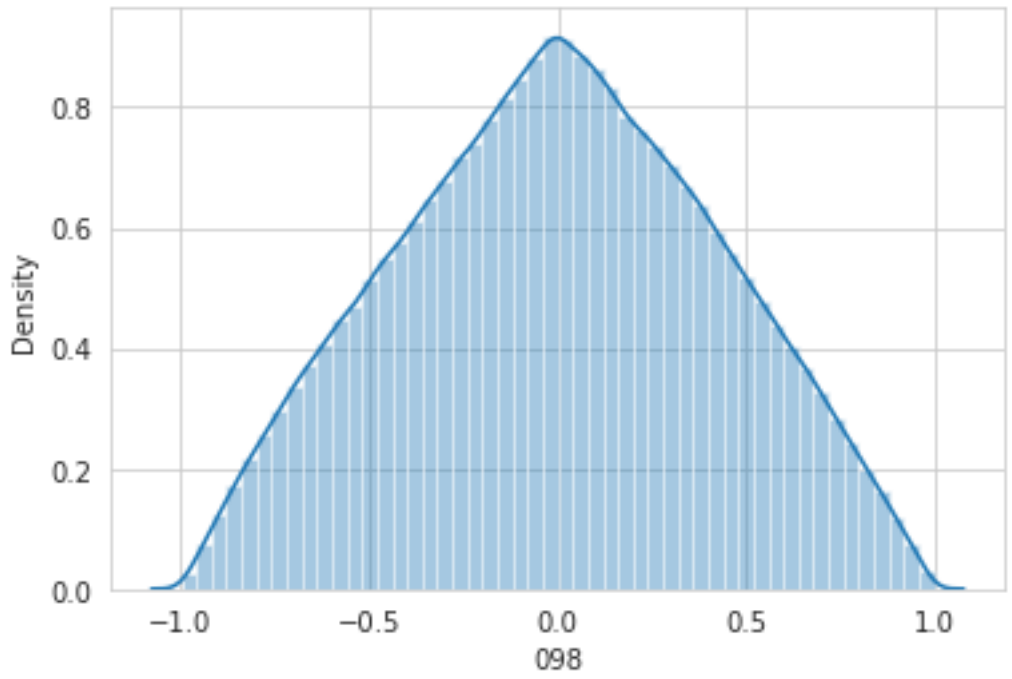
[255]:
```
alpha = 98
```

[256]:
```
%%time
alphas[f'{alpha:03}'] = alpha098(o, v, vwap)
```

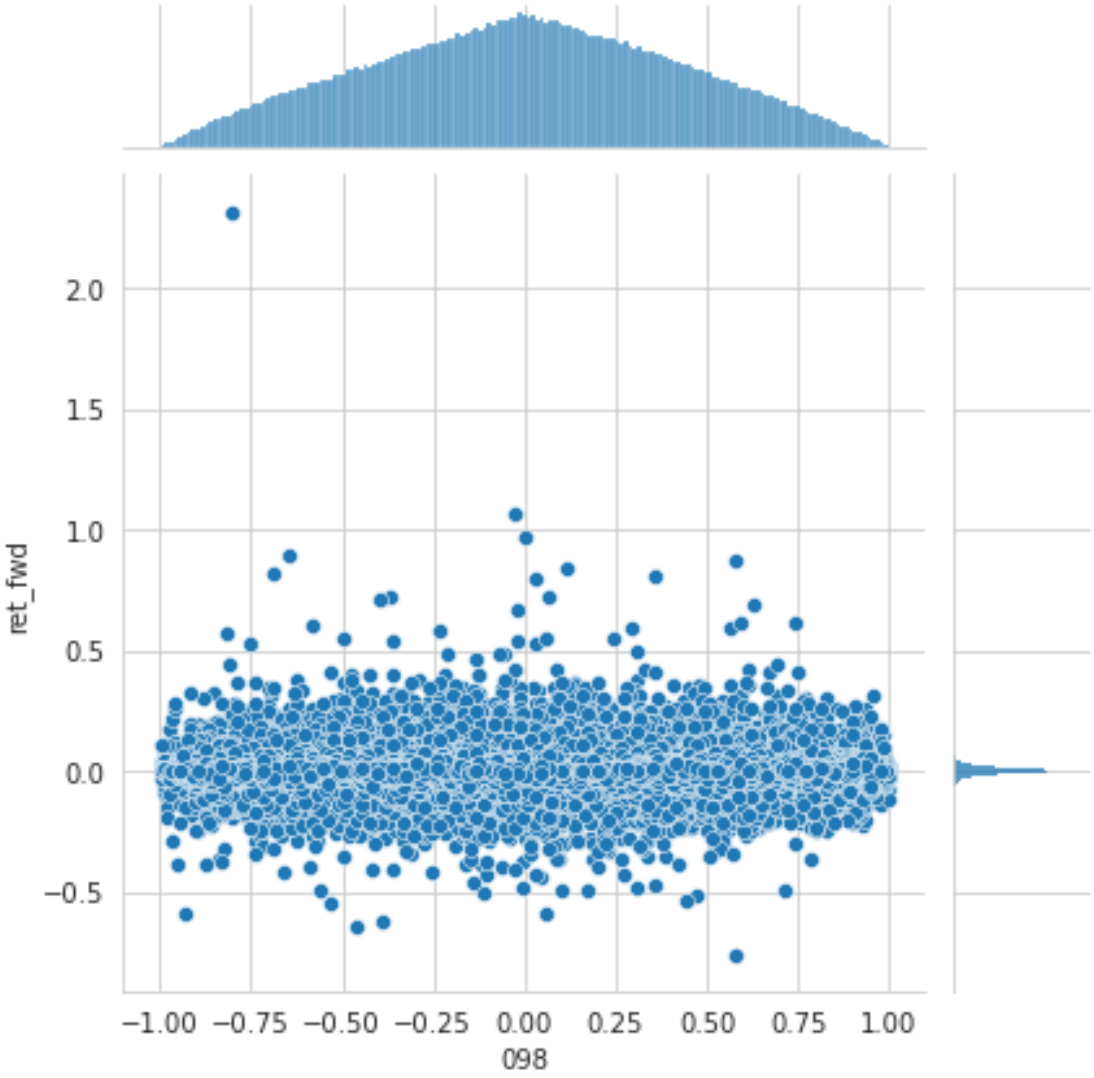
```
CPU times: user 4min 54s, sys: 389 ms, total: 4min 54s
Wall time: 4min 54s
```

[257]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[258]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[259]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[260]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[260]: 0

1.103 Alpha 099

```
((rank(ts_corr(ts_sum(((high + low) / 2), 19.8975),
                  ts_sum(adv60, 19.8975), 8.8136)) <
                  rank(ts_corr(low, volume, 6.28259))) * -1)
```

[261]:
```
def alpha099(l, v):
    """((rank(ts_corr(ts_sum(((high + low) / 2), 19.8975),
                  ts_sum(adv60, 19.8975), 8.8136)) <
```

```
                    rank(ts_corr(low, volume, 6.28259))) * -1)"""

    return ((rank(ts_corr(ts_sum((h.add(l).div(2)), 19),
                          ts_sum(ts_mean(v, 60), 19), 8))
             .lt(rank(ts_corr(l, v, 6)))
             .mul(-1))
            .stack('ticker')
            .swaplevel())
```

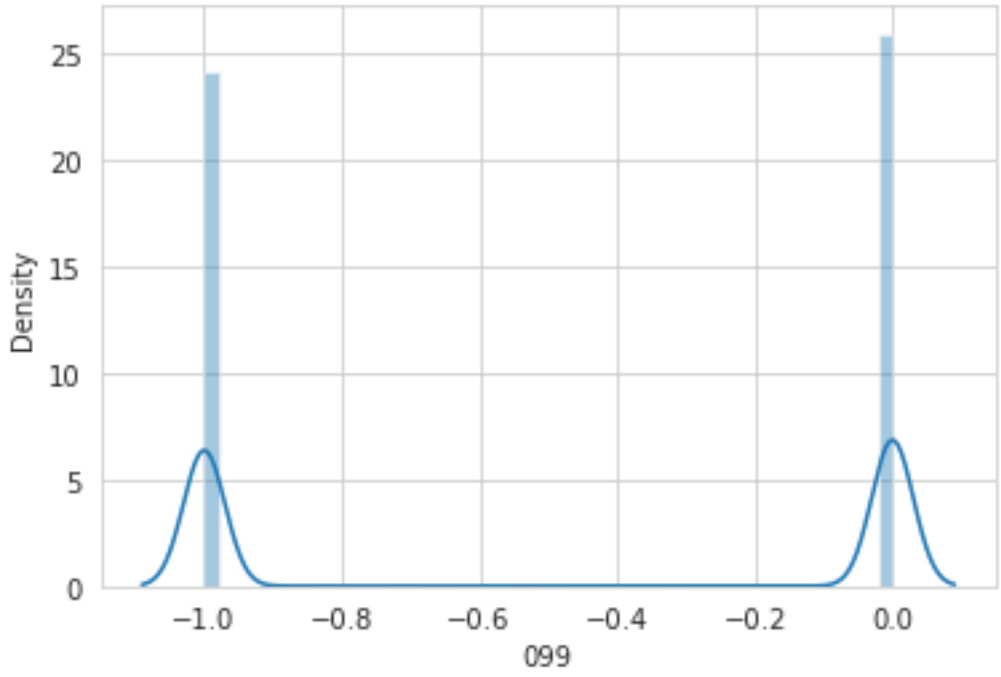
[262]:
```
alpha = 99
```

[263]:
```
%%time
alphas[f'{alpha:03}'] = alpha099(l, v)
```

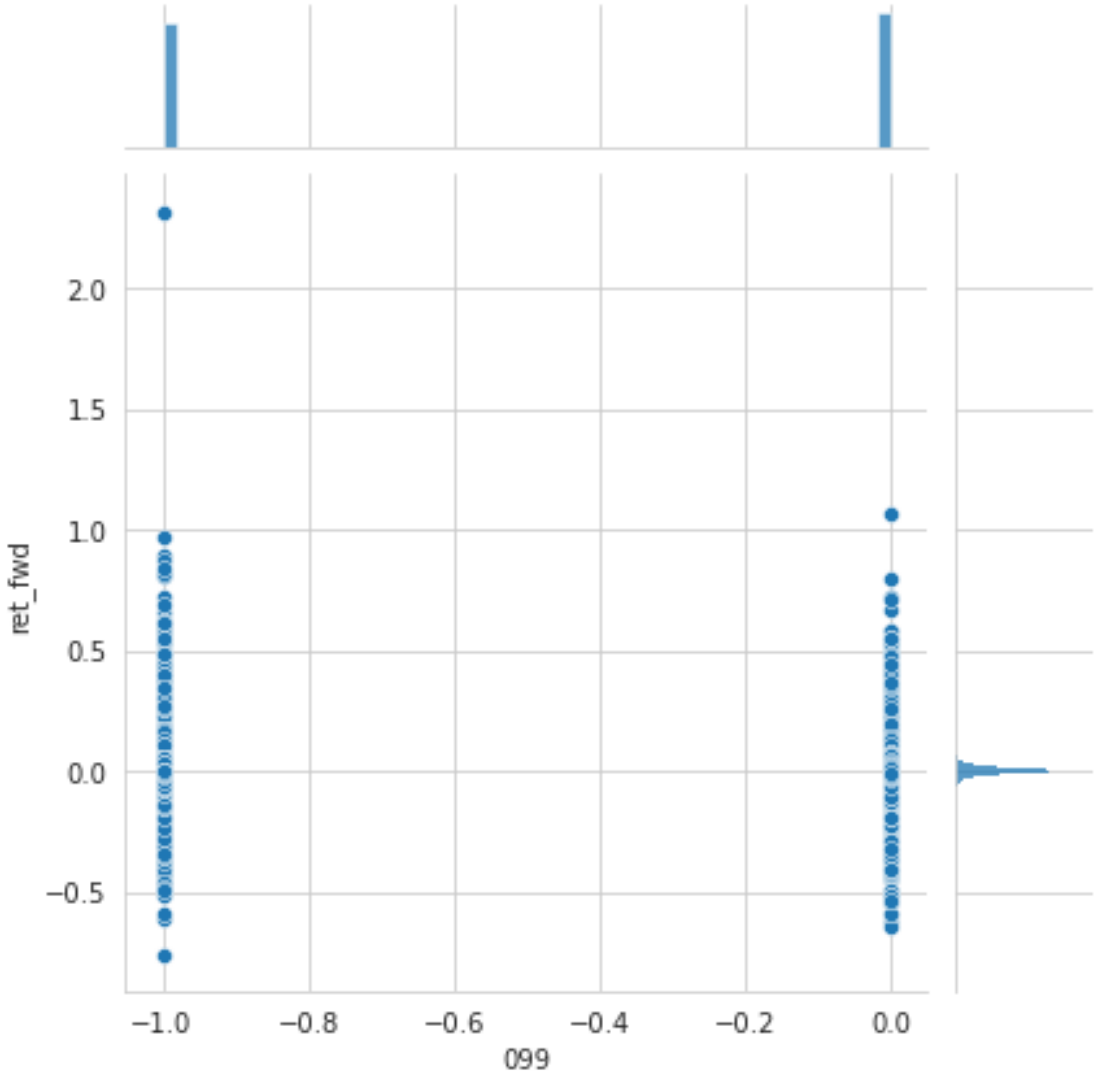
```
CPU times: user 4.53 s, sys: 21 µs, total: 4.53 s
Wall time: 4.44 s
```

[264]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[265]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[266]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[267]:
```
alphas.groupby(alphas[f'{alpha:03}']).ret_fwd.describe()
```

[267]:

099	count	mean	std	min	25%	50%	75%	max
-1	604583.0	0.000537	0.026239	-0.757755	-0.009783	0.000448	0.010714	2.317073
0	650510.0	0.000622	0.025303	-0.643066	-0.009524	0.000547	0.010625	1.061026

1.104 Alpha 100

```
-rank(ts_sum(returns, 10) / ts_sum(ts_sum(returns, 2), 3)) *
       rank((returns * cap))
```

[268]:
```
def alpha100(r, cap):
    """(0 - (1 * (((1.5 * scale(indneutralize(
                  indneutralize(rank(((((close - low) - (high -close)) / (high -␣
↪low)) * volume)),
                                IndClass.subindustry), IndClass.subindustry)))␣
↪-
    scale(indneutralize((ts_corr(close, rank(adv20), 5) - rank(ts_argmin(close,␣
↪30))), IndClass.subindustry))) * (volume / adv20))))
    """
    pass
```

1.105 Alpha 101

```
-ts_max(rank(ts_corr(rank(volume), rank(vwap), 5)), 5)
```

[269]:
```
def alpha101(o, h, l, c):
    """((close - open) / ((high - low) + .001))"""
    return (c.sub(o).div(h.sub(l).add(1e-3))
            .stack('ticker')
            .swaplevel())
```

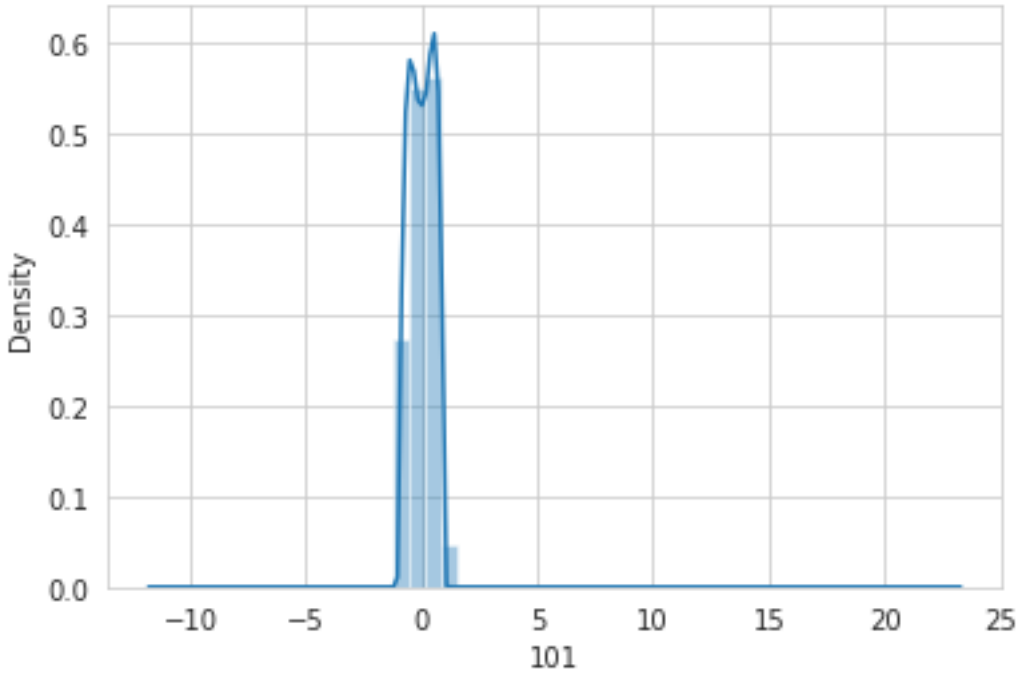
[270]:
```
alpha = 101
```

[271]:
```
%%time
alphas[f'{alpha:03}'] = alpha101(o, h, l, c)
```

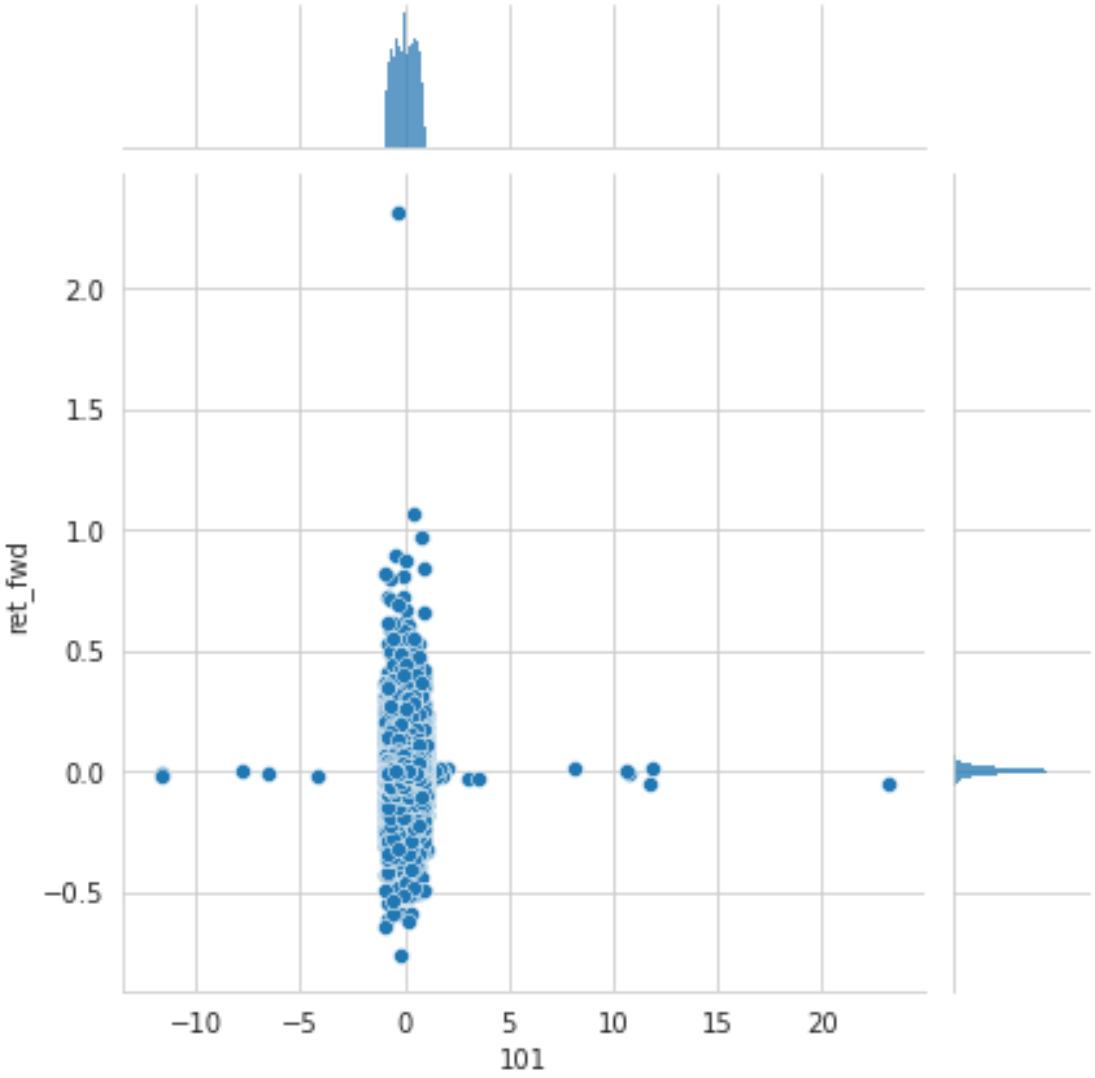
```
CPU times: user 1.89 s, sys: 12 ms, total: 1.9 s
Wall time: 1.87 s
```

[272]:
```
alphas[f'{alpha:03}'].to_hdf('alphas.h5', f'alphas/{alpha:03}')
```

[273]:
```
sns.distplot(alphas[f'{alpha:03}']);
```



[274]:
```
g = sns.jointplot(x=f'{alpha:03}', y='ret_fwd', data=alphas);
```



[275]:
```
mi[alpha] = get_mutual_info_score(alphas.ret_fwd, alphas[f'{alpha:03}'])
mi[alpha]
```

[275]: 0.0008757897861757513

1.106 Store results

[276]:
```
alphas = []
with pd.HDFStore('alphas.h5') as store:
    keys = [k[1:] for k in store.keys()]
    for key in keys:
        i = int(key.split('/')[-1])
        alphas.append(store[key].to_frame(i))
```

```
alphas = pd.concat(alphas, axis=1)
```

[277]:
```
alphas.info(null_counts=True)
```

```
<class 'pandas.core.frame.DataFrame'>
MultiIndex: 1255093 entries, ('A', Timestamp('2007-01-04 00:00:00')) to ('ZION',
Timestamp('2016-12-29 00:00:00'))
Data columns (total 82 columns):
 #   Column  Non-Null Count    Dtype
---  ------  --------------    -----
 0   1       1243849 non-null  float64
 1   2       1243080 non-null  float64
 2   3       1227126 non-null  float64
 3   4       1250757 non-null  float64
 4   5       1247733 non-null  float64
 5   6       1250204 non-null  float64
 6   7       1241633 non-null  float64
 7   8       1247172 non-null  float64
 8   9       1247548 non-null  float64
 9   10      1247548 non-null  float64
 10  11      1245756 non-null  float64
 11  12      1247548 non-null  float64
 12  13      1243849 non-null  float64
 13  14      1250204 non-null  float64
 14  15      1048657 non-null  float64
 15  16      1252899 non-null  float64
 16  17      1240819 non-null  float64
 17  18      1240862 non-null  float64
 18  19      1127248 non-null  float64
 19  20      1250162 non-null  float64
 20  21      1255093 non-null  int64
 21  22      1235676 non-null  float64
 22  23      1255093 non-null  float64
 23  24      1247006 non-null  float64
 24  25      1244833 non-null  float64
 25  26      1163949 non-null  float64
 26  27      1255093 non-null  float64
 27  28      1242843 non-null  float64
 28  29      1240358 non-null  float64
 29  30      1243877 non-null  float64
 30  31      2368 non-null     float64
 31  32      1126346 non-null  float64
 32  33      1250702 non-null  float64
 33  34      1246900 non-null  float64
 34  35      1237517 non-null  float64
 35  36      1144017 non-null  float64
 36  37      1143512 non-null  float64
```

```
 37  38      1247733 non-null  float64
 38  39      1123375 non-null  float64
 39  40      1250204 non-null  float64
 40  41      1255093 non-null  float64
 41  42      1250702 non-null  float64
 42  43      1235049 non-null  float64
 43  44      1249557 non-null  float64
 44  45      1226678 non-null  float64
 45  46      1247676 non-null  float64
 46  47      1244823 non-null  float64
 47  49      1254955 non-null  float64
 48  50      1181356 non-null  float64
 49  51      1254967 non-null  float64
 50  52      1132298 non-null  float64
 51  53      1244431 non-null  float64
 52  54      1255093 non-null  float64
 53  55      1243526 non-null  float64
 54  57      1229293 non-null  float64
 55  60      1250224 non-null  float64
 56  61      1255093 non-null  int64
 57  62      1255093 non-null  int64
 58  64      1255093 non-null  int64
 59  65      1255093 non-null  int64
 60  66      1240293 non-null  float64
 61  68      1255093 non-null  int64
 62  71      1239293 non-null  float64
 63  72      6612 non-null     float64
 64  73      1238793 non-null  float64
 65  74      1255093 non-null  int64
 66  75      1255093 non-null  int64
 67  77      1206268 non-null  float64
 68  78      1191505 non-null  float64
 69  81      1255093 non-null  int64
 70  83      1251765 non-null  float64
 71  84      1237712 non-null  float64
 72  85      1219026 non-null  float64
 73  86      1255093 non-null  int64
 74  88      33449 non-null    float64
 75  92      609037 non-null   float64
 76  94      1182264 non-null  float64
 77  95      1255093 non-null  int64
 78  96      53769 non-null    float64
 79  98      1068846 non-null  float64
 80  99      1255093 non-null  int64
 81  101     1255093 non-null  float64
dtypes: float64(70), int64(12)
memory usage: 790.8+ MB
```

[278]:
```
alphas.to_hdf('data.h5', 'factors/formulaic')
```