MOM-and-SMB

December 25, 2020

Consruction of SMB and MOM so that the two factors are neutralized with each other Fama-French style.

[40]:
```
import numpy as np
import pandas as pd
from pandas.tseries.offsets import MonthEnd, YearEnd
import datetime as dt
import matplotlib.pyplot as plt
import os
os.chdir("/Users/charlesrambo/Desktop/QIII/Quantitative Asset Management")
```

[41]:
```
# Load stock information
stocks = pd.read_csv("stocks.csv")
```

[42]:
```
# Record CRSP unkowns
unknowns = ["-66.0", "-77.0", "-88.0", "-99.0", "-99.99", "-999", "A", "B",␣
 ↪"C", "D", "E", "S", "T", "P"]

# Create function to convert CRISP unkowns to np.nan
convert_unknows = lambda x: np.nan if x in unknowns else x
```

[43]:
```
# Convert date column to date-time object
stocks['date'] = pd.to_datetime(stocks['date'], format = '%Y%m%d')

# Record observations where both returns and delisting returns are missing
stocks['flag'] = stocks['RET'].isna() & stocks['DLRET'].isna()

# Fill missing returns with 0
stocks['RET'] = stocks['RET'].apply(convert_unknows).astype(float).fillna(0)

# Fill missing delisting returns with 0
stocks['DLRET'] = stocks['DLRET'].apply(convert_unknows).astype(float).fillna(0)

# Compute log returns of the product
stocks['RET'] = np.log((1 + stocks['RET']) * (1 + stocks['DLRET']))

#Make stale prices positive
stocks['PRC'] = stocks['PRC'].abs()
```

```
# Remove 0 priced observations
stocks = stocks.loc[stocks['PRC'] > 0]

# Remove non-psitive shares outstanding
stocks = stocks.loc[stocks['SHROUT'] > 0]

# Only consider stocks listed on the big exchanges
stocks = stocks.loc[stocks['SHRCD'].isin([10, 11]) & stocks['EXCHCD'].isin([1,␣
↪2, 3])]

# Drop unneeded columns
stocks.drop(['DLRET', 'SHRCD', 'EXCHCD', 'PERMCO'], axis = 1, inplace = True)
```

```
/Users/charlesrambo/opt/anaconda3/lib/python3.7/site-
packages/pandas/core/series.py:679: RuntimeWarning: divide by zero encountered
in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```

[44]:
```
# Calculate market equity
stocks['ME'] = stocks['PRC'] * stocks['SHROUT']

# Short values for shift
stocks.sort_values(by = ['PERMNO', 'date'], inplace = True)

# Record the shifts which are valid
stocks['Isvalid'] = stocks['date'] + MonthEnd(0) == stocks['date'].shift(1) +␣
↪dt.timedelta(days = 7) + MonthEnd(0)
stocks.loc[stocks['Isvalid'] == True, 'Isvalid'] = stocks.loc[stocks['Isvalid']␣
↪== True, 'PERMNO'] == stocks.loc[stocks['Isvalid'] == True, 'PERMNO'].
↪shift(1)

# Shift market equity
stocks['ME_lag'] = stocks[['PERMNO', 'ME']].groupby('PERMNO')['ME'].shift(1)

# Replace the invalids with nan
stocks.loc[stocks['Isvalid'] == False, 'ME_lag'] = np.nan

# Drop unneeded columns
stocks.drop(['ME', 'Isvalid'], axis = 1, inplace = True)
```

[45]:
```
# Sort values again for another shift
stocks.sort_values(by = ['PERMNO', 'date'], inplace = True)

# Check to see if valid
stocks['Isvalid'] = stocks['date'] + MonthEnd(0) == stocks['date'].shift(12) +␣
↪dt.timedelta(days = 7) + MonthEnd(12)
```

```
stocks.loc[stocks['Isvalid'] == True, 'Isvalid'] = stocks.loc[stocks['Isvalid']␣
↪== True, 'PERMNO'] == stocks.loc[stocks['Isvalid'] == True, 'PERMNO'].
↪shift(12)

# Calculate momentum signal
stocks['MOM'] = stocks['RET'].shift(2).rolling(11).sum()

# Remove invalid observations
stocks.loc[stocks['Isvalid'] == False, 'MOM'] = np.nan

# Convert infinite returns to na
stocks['RET'] = stocks['RET'].replace([np.inf, -np.inf], np.nan)

# Remove observations with missing momentum signal
stocks = stocks.loc[stocks['MOM'].notna() & stocks['ME_lag'].notna() &␣
↪~stocks['flag'], :]

# Place firms into quintiles based on momentum signal
stocks['quintiles'] = stocks[['date', 'MOM']].groupby('date').transform(lambda␣
↪x: pd.qcut(x, 5, labels = False))

# Place firms into terciles based on lagged market equity
stocks['terciles'] = stocks[['date', 'ME_lag']].groupby('date').
↪transform(lambda x: pd.qcut(x, 5, labels = False))

# Drop uneeded columns
stocks.drop(['Isvalid', 'PRC', 'SHROUT', 'PERMNO', 'MOM', 'flag'], axis = 1,␣
↪inplace = True)
```

[46]:
```
# Compute weights for returns; value weighted
stocks['wt'] = stocks.groupby(['date', 'quintiles', 'terciles'])['ME_lag'].
↪transform('sum')
stocks['wt'] = stocks['ME_lag']/stocks['wt']

# Undo log return calculate
stocks['RET'] = stocks['RET'].apply(np.exp) - 1

# Weight returns
stocks['RET'] = stocks['RET'] * stocks['wt']

# Compute sume
W = stocks[['date', 'quintiles', 'terciles', 'RET']].groupby(['date',␣
↪'quintiles', 'terciles'])['RET'].sum().reset_index()

# Delete stocks
del stocks
```

```
# Add 1 to avoid confusion
W['quintiles'] = 1 + W['quintiles']
W['terciles'] = 1 + W['terciles']

W.head()
```

[46]:

	date	quintiles	terciles	RET
0	1974-12-31	1	1	-0.123868
1	1974-12-31	1	2	-0.108568
2	1974-12-31	1	3	-0.112908
3	1974-12-31	1	4	-0.043296
4	1974-12-31	1	5	-0.037697

[47]:
```
# Average accross the terciles for each quintile
quintiles = W.groupby(['date','quintiles'])['RET'].mean().reset_index()

# Pivot results
quintiles = quintiles.pivot(index = 'date', columns = 'quintiles', values =␣
 ↪'RET').reset_index()

# Calculate winners minus losers
quintiles['wml'] = quintiles[5] - quintiles[1]

# Only save date and wml
quintiles = quintiles[['date', 'wml']]

# Average across the quintiles for each tercile
terciles = W.groupby(['date', 'terciles'])['RET'].mean().reset_index()

# Pivot results
terciles = terciles.pivot(index = 'date', columns = 'terciles', values = 'RET').
 ↪reset_index()

# Calculate small minus big
terciles['smb'] = terciles[1] - terciles[3]

# Only save date and smb
terciles = terciles[['date', 'smb']]

# Merge results
final = quintiles.merge(terciles, on = 'date')


del quintiles, terciles, W
```

```
final.head()
```

[47]:

	date	wml	smb
0	1974-12-31	0.026612	-0.040848
1	1975-01-31	-0.219636	0.052705
2	1975-02-28	0.000127	0.035583
3	1975-03-31	-0.049968	0.015160
4	1975-04-30	0.028800	-0.020251

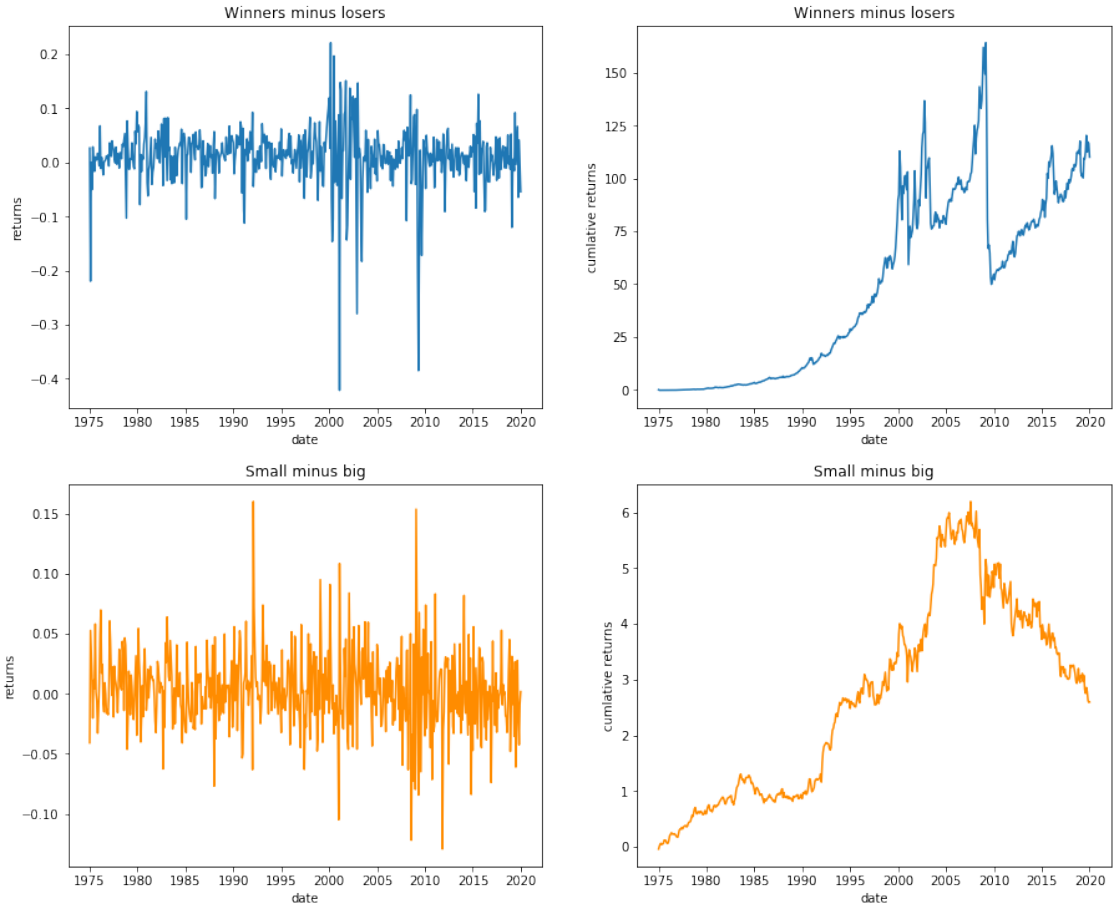
[48]:
```
stats = pd.DataFrame(index = final.columns[1:])

# Take a look at the mean
stats['mean'] = final.mean()

# Take a look at the sd
stats['sd'] = final.std()

# Take a look at the skew
stats['skew'] = final.skew()

stats
```

[48]:

	mean	sd	skew
wml	0.010419	0.055213	-2.120172
smb	0.002885	0.032247	0.206213

[54]:
```
# Plot returns
fig, axs = plt.subplots(2, 2, figsize = (15,5))
axs[0, 0].plot(final['date'], final['wml'])
axs[0, 0].set_xlabel('date')
axs[0, 0].set_ylabel('returns')
axs[0, 0].set_title('Winners minus losers')

axs[0, 1].plot(final['date'], (1 + final["wml"]).cumprod() - 1)
axs[0, 1].set_xlabel('date')
axs[0, 1].set_ylabel('cumlative returns')
axs[0, 1].set_title('Winners minus losers')

axs[1, 0].plot(final['date'], final['smb'], color = 'darkorange')
axs[1, 0].set_xlabel('date')
axs[1, 0].set_ylabel('returns')
axs[1, 0].set_title('Small minus big')

axs[1, 1].plot(final['date'], (1 + final['smb']).cumprod() - 1, color =␣
↪'darkorange')
axs[1, 1].set_xlabel('date')
axs[1, 1].set_ylabel('cumlative returns')
```

```
axs[1, 1].set_title('Small minus big')

plt.subplots_adjust(top = 2)
plt.show()
```



[50]:
```
# Correlation between factors
final['wml'].corr(final['smb'])
```

[50]: 0.010571748596490457