1_FF3_analysis_ver2

March 24, 2021

0.1 Volatility-Managed Portfolios

0.1.1 Part1: Comparasion between Returns Vs Scaled Returns

This is done for two different cases: 1. Current return scaled by the current volatility 2. Current return scaled by the previous volatility (same as the original paper)

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.linear_model import LinearRegression
sns.set(rc={'figure.figsize':(20, 7.5)})
```

A. Read the preprocessed monthly data (Part 0)

[2]:
```
monthly_mkt_rf = pd.read_csv("../../data/processed/mkt_rf/0_monthly_mkt_rf.csv",␣
 ↪index_col=0)
monthly_smb = pd.read_csv("../../data/processed/smb/0_monthly_smb.csv",␣
 ↪index_col=0)
monthly_hml = pd.read_csv("../../data/processed/hml/0_monthly_hml.csv",␣
 ↪index_col=0)
```

B. Calculate the scaled return using previous months volatility (here I use all the statistics calculated for the previous month)

[3]:
```
def include_lagd_scaled_returns(monthly_factor):
    monthly_factor["lagd_med_scald_ret"] = monthly_factor.curr_ret/
 ↪monthly_factor.lagd_med
    monthly_factor["lagd_mean_scald_ret"] = monthly_factor.curr_ret/
 ↪monthly_factor.lagd_mean
    monthly_factor["lagd_std_scald_ret"] = monthly_factor.curr_ret/
 ↪monthly_factor.lagd_std
    monthly_factor["lagd_var_scald_ret"] = monthly_factor.curr_ret/
 ↪monthly_factor.lagd_var
    monthly_factor["lagd_3mom_scald_ret"] = monthly_factor.curr_ret/
 ↪monthly_factor.lagd_3mom
```

```
    monthly_factor["lagd_3dev_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_3dev
    monthly_factor["lagd_4mom_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_4mom
    monthly_factor["lagd_4dev_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_4dev
    monthly_factor["lagd_5mom_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_5mom
    monthly_factor["lagd_5dev_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_5dev
    monthly_factor["lagd_skew_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_skew
    monthly_factor["lagd_kurt_scald_ret"] = monthly_factor.curr_ret/
↪monthly_factor.lagd_kurt

    return monthly_factor
```

[4]:
```
monthly_mkt_rf = include_lagd_scaled_returns(monthly_factor=monthly_mkt_rf)
monthly_smb = include_lagd_scaled_returns(monthly_factor=monthly_smb)
monthly_hml = include_lagd_scaled_returns(monthly_factor=monthly_hml)
```

[5]:
```
bag_kinds_all = ["med_bag","mean_bag","std_bag","var_bag",\
                 "3mom_bag","3dev_bag","4mom_bag","4dev_bag",\
                 "5mom_bag","5dev_bag","skew_bag","kurt_bag"]
bag_kinds = bag_kinds_all[:4] + bag_kinds_all[-2:]

corres_curr_all = ["curr_med","curr_mean","curr_std","curr_var",\
                   "curr_3mom","curr_3dev","curr_4mom","curr_4dev",\
                   "curr_5mom","curr_5dev","curr_skew","curr_kurt"]
corres_curr = corres_curr_all[:4] + corres_curr_all[-2:]

corres_scald_ret_all = ["curr_med_scald_ret","curr_mean_scald_ret",\
                        "curr_std_scald_ret","curr_var_scald_ret",\
                        "curr_3mom_scald_ret","curr_3dev_scald_ret",\
                        "curr_4mom_scald_ret","curr_4dev_scald_ret",\
                        "curr_5mom_scald_ret","curr_5dev_scald_ret",\
                        "curr_skew_scald_ret","curr_kurt_scald_ret"]
corres_scald_ret = corres_scald_ret_all[:4] + corres_scald_ret_all[-2:]

lagd_scald_ret_all = ["lagd_med_scald_ret","lagd_mean_scald_ret",\
                      "lagd_std_scald_ret","lagd_var_scald_ret",\
                      "lagd_3mom_scald_ret","lagd_3dev_scald_ret",\
                      "lagd_4mom_scald_ret","lagd_4dev_scald_ret",\
                      "lagd_5mom_scald_ret","lagd_5dev_scald_ret",\
                      "lagd_skew_scald_ret","lagd_kurt_scald_ret"]
lagd_scald_ret = lagd_scald_ret_all[:4] + lagd_scald_ret_all[-2:]
```

```
corres_names_all = ["Median","Mean","STD","Variance",\
                    "3rd Moment","3rd STD","4th Moment","4th STD",\
                    "5th Moment", "5th STD", "Skewness", "Kurtosis"]
corres_names = corres_names_all[:4] + corres_names_all[-2:]
```

C. Linear Regression Current return Vs Scaled return

[6]:
```
def factor_linear_regression(factor_dataframe, scald_ret):
    LR_dict = dict()
    for i, stat in enumerate(corres_curr):
        LR = LinearRegression()
        df = factor_dataframe[["curr_ret", scald_ret[i]]].copy()
        df.replace([np.inf, -np.inf], np.nan, inplace=True)
        df = df.dropna()
        LR.fit(y=df[scald_ret[i]],\
               X=df[["curr_ret"]])
        LR_dict[stat] = LR

    return LR_dict
```

[7]:
```
def plot_1(factor_name, monthly_factor, LR_dict_curr, LR_dict_lagd, nos_bags=5):

    _x = np.expand_dims(np.linspace(monthly_factor["curr_ret"].min(),\
                                    monthly_factor["curr_ret"].max()), axis=1)
    fig, ax = plt.subplots(6,2,figsize=(15,7.5*len(corres_curr)))
    fig.suptitle(factor_name, fontsize=20)
    for i in range(len(corres_curr)):
        stat = corres_curr[i]
        _LR1 = LR_dict_curr[stat]
        _y = _LR1.predict(_x)
        ax[i,0].plot(_x, _y, linewidth=1, color="black")
        ax[i,0].set_title("Current %s scaled current return\nalpha: %.2f beta: %.
↪2f"\
                          %(corres_names[i], _LR1.intercept_,_LR1.coef_[0]))
        _bag = bag_kinds[i] + "_in{}".format(nos_bags)
        sns.scatterplot(ax=ax[i,0], data=monthly_factor, x="curr_ret",\
                        y=corres_scald_ret[i], hue=_bag)
        ax[i,0].set(xlabel="Current return")
        ax[i,0].set(ylabel="Current {} scaled current return".
↪format(corres_names[i]))

        _LR2 = LR_dict_lagd[stat]
        _y = _LR2.predict(_x)
        ax[i,1].plot(_x, _y, linewidth=1, color="black")
        ax[i,1].set_title("Lagged %s scaled current return\nalpha: %.2f beta: %.
↪2f"\
```

```
                        %(corres_names[i], _LR2.intercept_,_LR2.coef_[0]))
        _bag = bag_kinds[i] + "_in{}".format(nos_bags)
        sns.scatterplot(ax=ax[i,1], data=monthly_factor, x="curr_ret",\
                        y=lagd_scald_ret[i], hue=_bag)
        ax[i,1].set(xlabel="Current return")
        ax[i,1].set(ylabel="Lagged {} scaled current return".
↪format(corres_names[i]))

    plt.show()
```

[8]:
```
def alphas_table(factor_name, LR_dict_curr, LR_dict_lagd):

    Names = list()
    Alphas = list()

    for name, curr in zip(corres_names, corres_curr):
        Names.append(name)
        Names.append("Lagged(1) {}".format(name))
        Alphas.append(LR_dict_curr[curr].intercept_)
        Alphas.append(LR_dict_lagd[curr].intercept_)

    tmp_df = pd.DataFrame({"Model":Names, "Alpha":Alphas})
    return tmp_df.set_index("Model")
```

D.1. Mkt-RF

[9]:
```
mkt_rf_LR_dict_curr = factor_linear_regression(factor_dataframe=monthly_mkt_rf,␣
↪scald_ret=corres_scald_ret)
mkt_rf_LR_dict_lagd = factor_linear_regression(factor_dataframe=monthly_mkt_rf,␣
↪scald_ret=lagd_scald_ret)
```

[10]:
```
mkt_rf_alphas = alphas_table(factor_name="Mkt-RF",␣
↪LR_dict_curr=mkt_rf_LR_dict_curr,\
                             LR_dict_lagd=mkt_rf_LR_dict_lagd)
mkt_rf_alphas
```

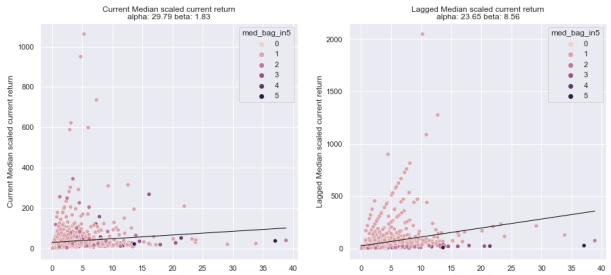
[10]:

Model	Alpha
Median	29.787427
Lagged(1) Median	23.654903
Mean	22.982006
Lagged(1) Mean	29.137500
STD	2.695778
Lagged(1) STD	2.151539
Variance	6.755672
Lagged(1) Variance	5.532892
Skewness	15.179275

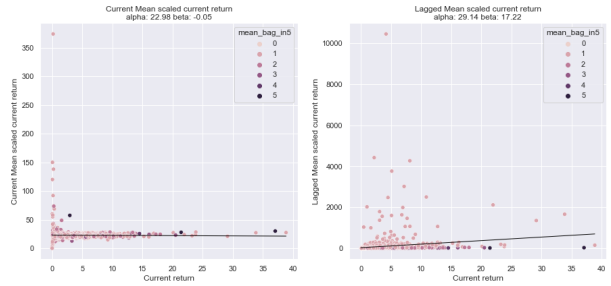
```
Lagged(1) Skewness   3.398042
Kurtosis            10.452350
Lagged(1) Kurtosis   0.651050
```

[11]:
```
plot_1(factor_name="Mkt-RF", monthly_factor=monthly_mkt_rf,\
       LR_dict_curr=mkt_rf_LR_dict_curr, LR_dict_lagd=mkt_rf_LR_dict_lagd)
```

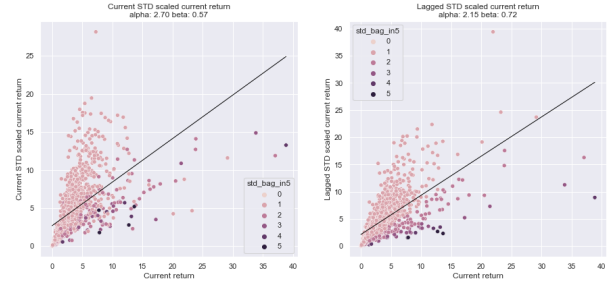
Mkt-RF


Current Median scaled current return
alpha: 29.79 beta: 1.83
Current Median scaled current return
Current return
med_bag_in5

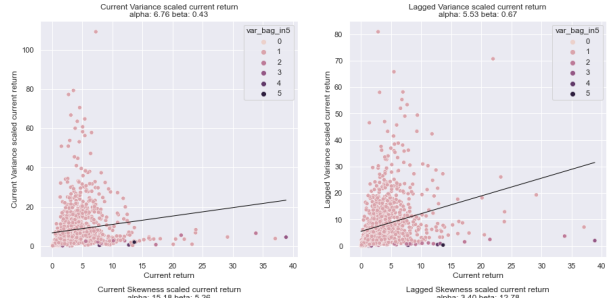
Lagged Median scaled current return
alpha: 23.65 beta: 8.56
Lagged Median scaled current return
Current return
med_bag_in5


Current Mean scaled current return
alpha: 22.98 beta: -0.05
Current Mean scaled current return
Current return
mean_bag_in5

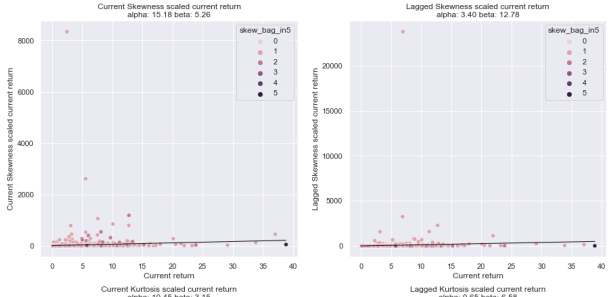
Lagged Mean scaled current return
alpha: 29.14 beta: 17.22
Lagged Mean scaled current return
Current return
mean_bag_in5


Current STD scaled current return
alpha: 2.70 beta: 0.57
Current STD scaled current return
Current return
std_bag_in5

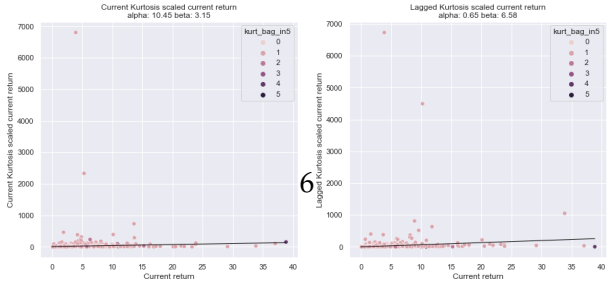
Lagged STD scaled current return
alpha: 2.15 beta: 0.72
Lagged STD scaled current return
Current return
std_bag_in5


Current Variance scaled current return
alpha: 6.76 beta: 0.43
Current Variance scaled current return
Current return
var_bag_in5

Lagged Variance scaled current return
alpha: 5.53 beta: 0.67
Lagged Variance scaled current return
Current return
var_bag_in5


Current Skewness scaled current return
alpha: 15.18 beta: 5.26
Current Skewness scaled current return
Current return
skew_bag_in5

Lagged Skewness scaled current return
alpha: 3.40 beta: 12.78
Lagged Skewness scaled current return
Current return
skew_bag_in5


Current Kurtosis scaled current return
alpha: 10.45 beta: 3.15
Current Kurtosis scaled current return
Current return
kurt_bag_in5

Lagged Kurtosis scaled current return
alpha: 0.65 beta: 6.58
Lagged Kurtosis scaled current return
Current return
kurt_bag_in5

D.2. SMB

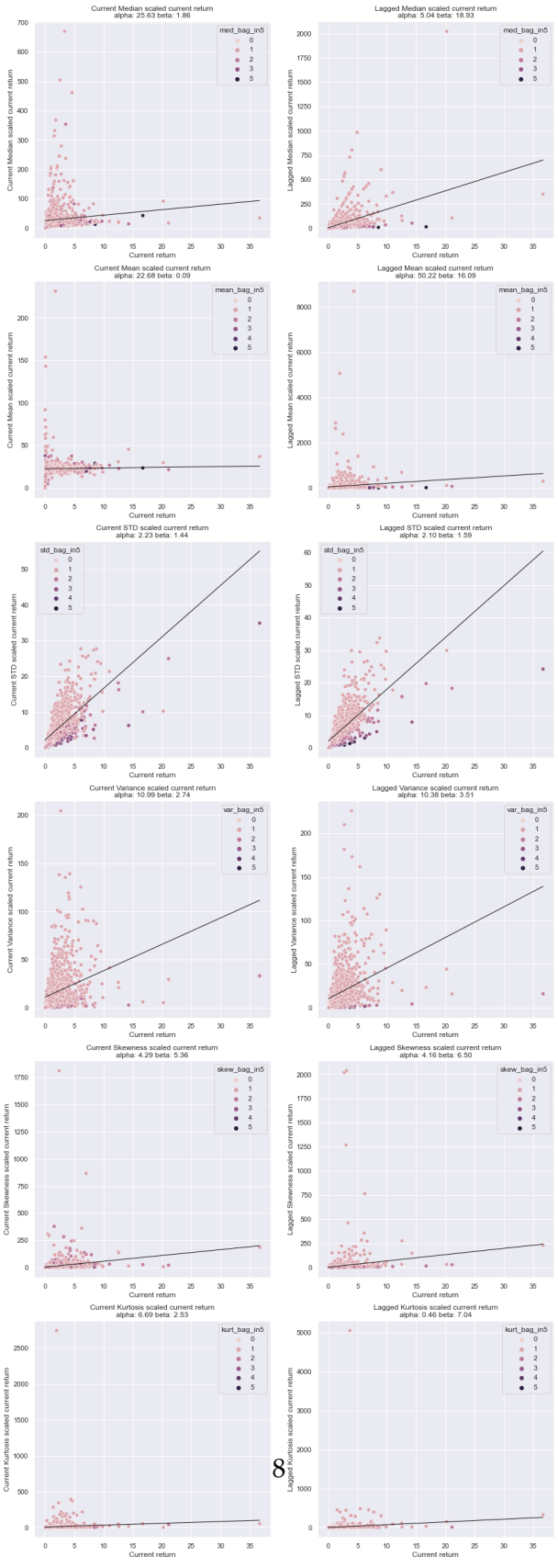
[12]:
```
smb_LR_dict_curr = factor_linear_regression(factor_dataframe=monthly_smb,␣
↪scald_ret=corres_scald_ret)
smb_LR_dict_lagd = factor_linear_regression(factor_dataframe=monthly_smb,␣
↪scald_ret=lagd_scald_ret)
```

[13]:
```
smb_alphas = alphas_table(factor_name="SMB", LR_dict_curr=smb_LR_dict_curr,\
                          LR_dict_lagd=smb_LR_dict_lagd)
smb_alphas
```

[13]:

Model	Alpha
Median	25.634464
Lagged(1) Median	5.035849
Mean	22.682999
Lagged(1) Mean	50.215202
STD	2.234622
Lagged(1) STD	2.095132
Variance	10.988604
Lagged(1) Variance	10.377667
Skewness	4.292246
Lagged(1) Skewness	4.161461
Kurtosis	6.690173
Lagged(1) Kurtosis	0.464449

[14]:
```
plot_1(factor_name="SMB", monthly_factor=monthly_smb,\
       LR_dict_curr=smb_LR_dict_curr, LR_dict_lagd=smb_LR_dict_lagd)
```


Current Median scaled current return
alpha: 25.63 beta: 1.86
Lagged Median scaled current return
alpha: 5.04 beta: 18.93
Current Mean scaled current return
alpha: 22.68 beta: 0.09
Lagged Mean scaled current return
alpha: 50.22 beta: 16.09
Current STD scaled current return
alpha: 2.23 beta: 1.44
Lagged STD scaled current return
alpha: 2.10 beta: 1.59
Current Variance scaled current return
alpha: 10.99 beta: 2.74
Lagged Variance scaled current return
alpha: 10.38 beta: 3.51
Current Skewness scaled current return
alpha: 4.29 beta: 5.36
Lagged Skewness scaled current return
alpha: 4.16 beta: 6.50
Current Kurtosis scaled current return
alpha: 6.69 beta: 2.53
Lagged Kurtosis scaled current return
alpha: 0.46 beta: 7.04
med_bag_in5
mean_bag_in5
std_bag_in5
var_bag_in5
skew_bag_in5
kurt_bag_in5
Current return

D.3. HML

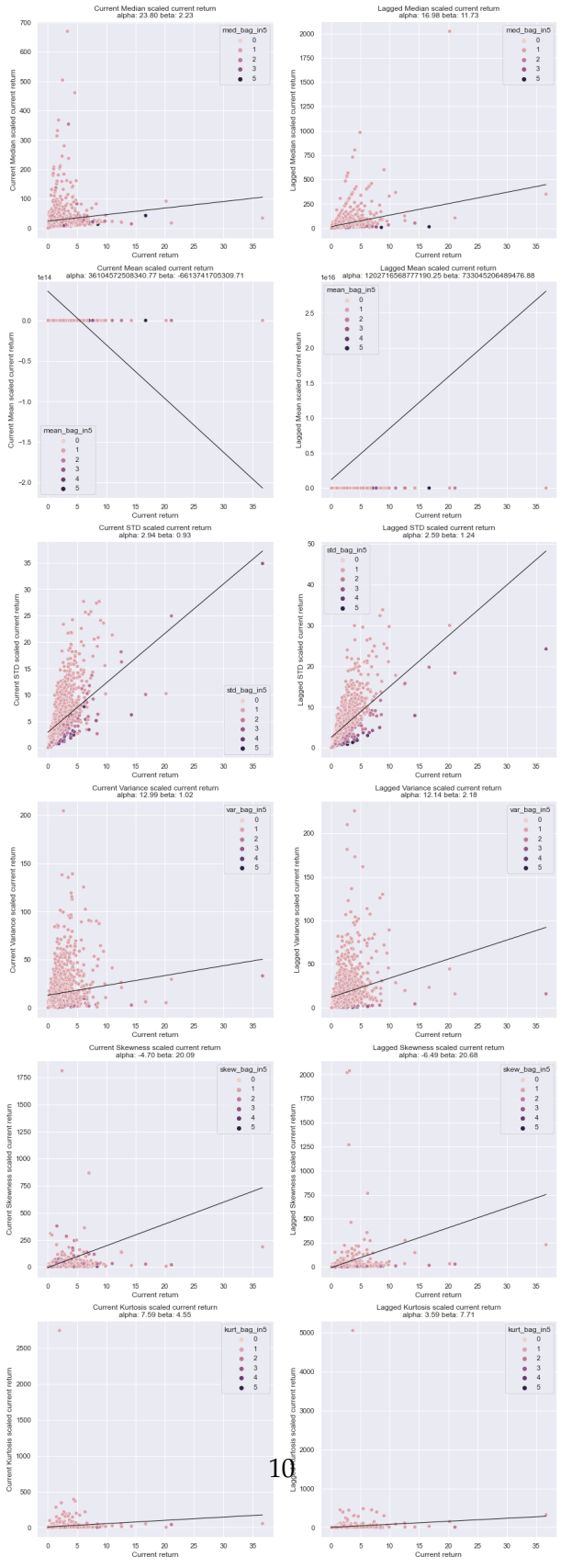
[15]:
```
hml_LR_dict_curr = factor_linear_regression(factor_dataframe=monthly_hml,␣
↪scald_ret=corres_scald_ret)
hml_LR_dict_lagd = factor_linear_regression(factor_dataframe=monthly_hml,␣
↪scald_ret=lagd_scald_ret)
```

[16]:
```
hml_alphas = alphas_table(factor_name="HML", LR_dict_curr=hml_LR_dict_curr,\
                          LR_dict_lagd=hml_LR_dict_lagd)
hml_alphas
```

[16]:

Model	Alpha
Median	2.379869e+01
Lagged(1) Median	1.697652e+01
Mean	3.610457e+13
Lagged(1) Mean	1.202717e+15
STD	2.944977e+00
Lagged(1) STD	2.586580e+00
Variance	1.298635e+01
Lagged(1) Variance	1.213677e+01
Skewness	-4.701215e+00
Lagged(1) Skewness	-6.492491e+00
Kurtosis	7.587051e+00
Lagged(1) Kurtosis	3.585114e+00

[17]:
```
plot_1(factor_name="HML", monthly_factor=monthly_smb,\
       LR_dict_curr=hml_LR_dict_curr, LR_dict_lagd=hml_LR_dict_lagd)
```


Current Median scaled current return
alpha: 23.80 beta: 2.23
Lagged Median scaled current return
alpha: 16.98 beta: 11.73
Current Mean scaled current return
alpha: 36104572508340.77 beta: -6613741705309.71
Lagged Mean scaled current return
alpha: 1202716568777190.25 beta: 73304520648947 6.88
Current STD scaled current return
alpha: 2.04 beta: 0.93
Lagged STD scaled current return
alpha: 2.09 beta: 1.24
Current Variance scaled current return
alpha: 12.99 beta: 1.02
Lagged Variance scaled current return
alpha: 12.14 beta: 2.18
Current Skewness scaled current return
alpha: -4.70 beta: 20.09
Lagged Skewness scaled current return
alpha: -6.49 beta: 20.68
Current Kurtosis scaled current return
alpha: 7.59 beta: 4.55
Lagged Kurtosis scaled current return
alpha: 3.59 beta: 7.71
Current return
med_bag_in5
mean_bag_in5
std_bag_in5
var_bag_in5
skew_bag_in5
kurt_bag_in5

E. Saving

[18]:
```
mkt_rf_alphas.to_csv("../../data/metrics/mkt_rf/1_metrics_mkt_rf.csv")
smb_alphas.to_csv("../../data/metrics/smb/1_metrics_smb.csv")
hml_alphas.to_csv("../../data/metrics/hml/1_metrics_hml.csv")
```

[19]:
```
monthly_mkt_rf.to_csv("../../data/processed/mkt_rf/1_monthly_mkt_rf.csv")
monthly_smb.to_csv("../../data/processed/smb/1_monthly_smb.csv")
monthly_hml.to_csv("../../data/processed/hml/1_monthly_hml.csv")
```