Carrie_Little_AAI_500_FinalProject_FamaFrench

October 3, 2024

# 1 Risk Parity - Opportunity dataset

Carrie Little

### 1.0.1 Import Necessary Libraries

[1]:
```
# Carrie Little - AAI5000 Final Project Code
#
# Import All Necessary Libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
import cvxpy as cp
```

### 1.0.2 Models

Fama-French Factor Model

[2]:
```
# http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
fama_french_factors = pd.read_csv('F-F_Research_Data_Factors.csv',␣
↪parse_dates=['Date'])      # Load Dataset as Dataframe
fama_french_factors.head()                                                     ␣
↪                              # Diaplay 1st 5 inDataframe
```

[2]:

| | Date | Mkt-RF | SMB | HML | RF |
|---|---|---|---|---|---|
| 0 | 2014-11-30 | 2.55 | -2.06 | -3.10 | 0.0 |
| 1 | 2014-12-31 | -0.06 | 2.49 | 2.27 | 0.0 |
| 2 | 2015-01-31 | -3.11 | -0.56 | -3.59 | 0.0 |
| 3 | 2015-02-28 | 6.13 | 0.63 | -1.86 | 0.0 |
| 4 | 2015-03-31 | -1.12 | 3.04 | -0.38 | 0.0 |

[3]:
```
df = pd.read_csv('Opportunity_Set.csv', parse_dates=['Date'])      # Load␣
↪Dataset as Dataframe
df.head()
```

[3]:
```
         Date  Vanguard LifeStrategy Income Fund (VASIX)  \
0 2014-11-30                                     0.0094
1 2014-12-31                                    -0.0005
2 2015-01-31                                     0.0141
3 2015-02-28                                     0.0033
4 2015-03-31                                     0.0018

   Vanguard Total World Stock ETF (VT)  \
0                               0.0126
1                              -0.0199
2                              -0.0163
3                               0.0595
4                              -0.0121

   PIMCO 25+ Year Zero Coupon US Trs ETF (ZROZ)  \
0                                        0.0414
1                                        0.0612
2                                        0.1600
3                                       -0.1007
4                                        0.0117

   AQR Diversified Arbitrage I (ADAIX)  iShares Gold Trust (IAU)  \
0                              -0.0066                   -0.0053
1                              -0.0117                    0.0133
2                              -0.0059                    0.0865
3                               0.0069                   -0.0579
4                               0.0000                   -0.0222

   Bitcoin Market Price USD (^BTC)  \
0                           0.0969
1                          -0.1777
2                          -0.2677
3                           0.1062
4                          -0.0150

   AQR Risk-Balanced Commodities Strategy I (ARCIX)  \
0                                           -0.0726
1                                           -0.0412
2                                           -0.0287
3                                            0.0044
4                                           -0.0573

   AQR Long-Short Equity I (QLEIX)  AQR Style Premia Alternative I (QSPIX)  \
0                           0.0248                                  0.0412
1                           0.0140                                  0.0002
2                           0.0156                                 -0.0112
3                           0.0236                                 -0.0390
```

```
4                       -0.0027                              0.0256

   AQR Equity Market Neutral I (QMNIX)  AQR Macro Opportunities I (QGMIX)  \
0                               0.0257                             0.0154
1                               0.0195                             0.0039
2                               0.0290                            -0.0070
3                              -0.0078                             0.0091
4                               0.0049                             0.0261

   AGF U.S. Market Neutral Anti-Beta (BTAL)  \
0                                    0.0235
1                                    0.0294
2                                    0.0320
3                                   -0.0568
4                                    0.0000

   AQR Managed Futures Strategy HV I (QMHIX)  \
0                                     0.1159
1                                     0.0461
2                                     0.0721
3                                    -0.0108
4                                     0.0655

   Invesco DB US Dollar Bullish (UUP)  ProShares VIX Mid-Term Futures (VIXM)
0                              0.0165                                -0.0298
1                              0.0213                                 0.0553
2                              0.0484                                 0.0762
3                              0.0028                                -0.1145
4                              0.0278                                 0.0033
```

[4]:

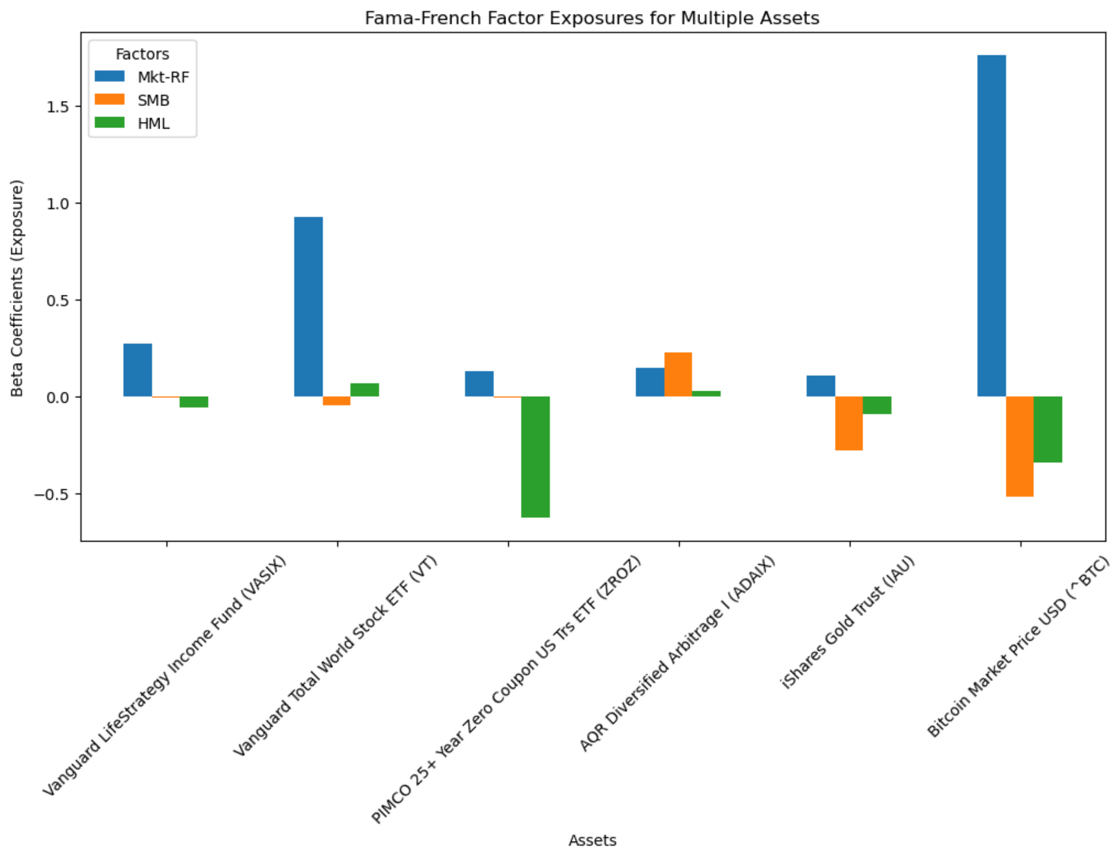
```python
import pandas as pd
import statsmodels.api as sm

asset_return = df['Vanguard LifeStrategy Income Fund (VASIX)']  # Replace with␣
 ↪asset name

# Step 3: Prepare the factors and align with asset returns by date
factor_returns = fama_french_factors[['Mkt-RF', 'SMB', 'HML']] # Ensure both␣
 ↪asset returns and factors are aligned by date
factor_returns_RF = fama_french_factors['RF']  # Risk-free rate
excess_asset_returns = asset_return - factor_returns_RF # Calculate excess␣
 ↪returns over risk-free rate

# Add a constant (alpha) to the model
X = sm.add_constant(factor_returns[['Mkt-RF', 'SMB', 'HML']])
y = excess_asset_returns
```

```python
# Fit the model
model = sm.OLS(y, X).fit()

# Display the summary of the regression
print(model.summary())
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                      y   R-squared:                       0.025
Model:                            OLS   Adj. R-squared:                 -0.001
Method:                 Least Squares   F-statistic:                    0.9667
Date:                Thu, 03 Oct 2024   Prob (F-statistic):              0.411
Time:                        05:43:47   Log-Likelihood:                 57.434
No. Observations:                 118   AIC:                            -106.9
Df Residuals:                     114   BIC:                            -95.78
Df Model:                           3
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -0.1267      0.014     -8.839      0.000      -0.155      -0.098
Mkt-RF         0.0016      0.003      0.518      0.605      -0.005       0.008
SMB            0.0066      0.005      1.260      0.210      -0.004       0.017
HML            0.0020      0.004      0.532      0.596      -0.005       0.009
==============================================================================
Omnibus:                       18.265   Durbin-Watson:                   0.069
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               22.950
Skew:                          -1.080   Prob(JB):                     1.04e-05
Kurtosis:                       2.930   Cond. No.                         4.91
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly
specified.
```

[5]:
```python
# Merge the two datasets on the 'Date' column
merged_df = pd.merge(df, fama_french_factors, on='Date')

# Set the index to 'Date' for easier handling
merged_df.set_index('Date', inplace=True)

# Prepare the assets for regression (list of asset columns)
asset_columns = [
    'Vanguard LifeStrategy Income Fund (VASIX)',
    'Vanguard Total World Stock ETF (VT)',
    'PIMCO 25+ Year Zero Coupon US Trs ETF (ZROZ)',
    'AQR Diversified Arbitrage I (ADAIX)',
```

```python
    'iShares Gold Trust (IAU)',
    'Bitcoin Market Price USD (^BTC)'
]

# We need to calculate excess returns for the assets (subtracting the risk-free␣
 ↪rate RF)
for asset in asset_columns:
    merged_df[asset] = merged_df[asset] - (merged_df['RF'] / 100)  # Converting␣
 ↪RF to percentage

# Prepare the factor data for the regression (convert from percentage to␣
 ↪decimal)
factor_columns = ['Mkt-RF', 'SMB', 'HML']
merged_df[factor_columns] = merged_df[factor_columns] / 100

# Perform Fama-French 3-factor regression for each asset
import statsmodels.api as sm

betas = pd.DataFrame()

for asset in asset_columns:
    X = sm.add_constant(merged_df[factor_columns])  # Add constant (alpha)
    y = merged_df[asset]  # Asset's excess returns
    model = sm.OLS(y, X).fit()  # Fit OLS regression

    # Collect the coefficients (betas) for each asset
    betas[asset] = model.params[1:]  # Ignore the intercept (alpha), take only␣
 ↪factor betas

# Rename the index for factors
betas.index = factor_columns
betas

# Now we can visualize the beta exposures for all assets
betas.T.plot(kind='bar', figsize=(12, 6))
plt.title('Fama-French Factor Exposures for Multiple Assets')
plt.xlabel('Assets')
plt.ylabel('Beta Coefficients (Exposure)')
plt.xticks(rotation=45)
plt.legend(title='Factors')

# Display the plot
plt.show()
```




[6]:
```
# Let's extend the analysis to include all assets in the opportunity dataset.

# Extract all asset columns (ignoring the factor columns)
all_asset_columns = merged_df.columns.difference(factor_columns + ['RF']).
↪tolist()

# Initialize an empty DataFrame to store the betas for all assets
all_betas = pd.DataFrame()

# Perform Fama-French 3-factor regression for each asset
for asset in all_asset_columns:
    X = sm.add_constant(merged_df[factor_columns])  # Add constant (alpha)
    y = merged_df[asset]  # Asset's excess returns
    model = sm.OLS(y, X).fit()  # Fit OLS regression

    # Collect the coefficients (betas) for each asset
    all_betas[asset] = model.params[1:]  # Ignore the intercept (alpha), take␣
↪only factor betas

# Rename the index for factors
```

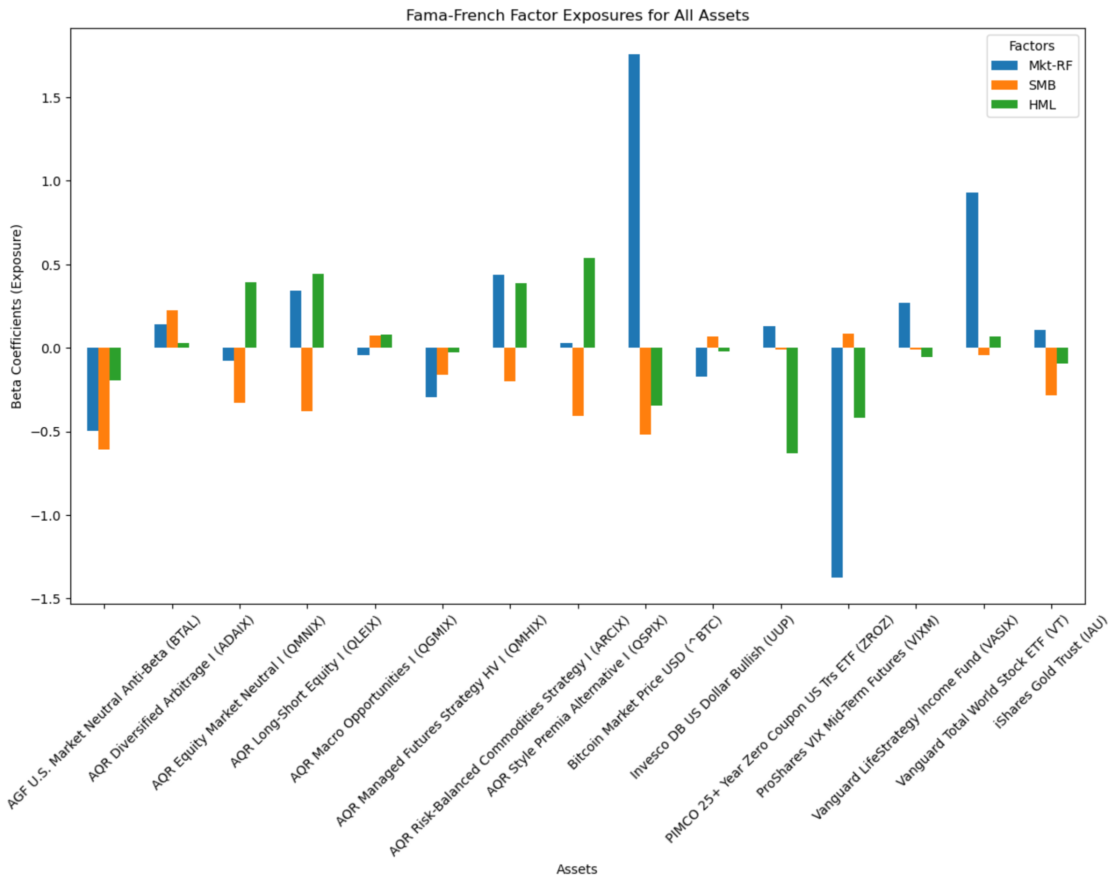
```
all_betas.index = factor_columns

all_betas
```

```
[6]:         AGF U.S. Market Neutral Anti-Beta (BTAL)  \
Mkt-RF                                     -0.496720
SMB                                        -0.610488
HML                                        -0.195573

        AQR Diversified Arbitrage I (ADAIX)  \
Mkt-RF                             0.143773
SMB                                0.226056
HML                                0.028488

        AQR Equity Market Neutral I (QMNIX)  AQR Long-Short Equity I (QLEIX)  \
Mkt-RF                            -0.079728                        0.342733
SMB                               -0.325849                       -0.377814
HML                                0.390752                        0.442353

        AQR Macro Opportunities I (QGMIX)  \
Mkt-RF                          -0.043512
SMB                              0.074967
HML                              0.078516

        AQR Managed Futures Strategy HV I (QMHIX)  \
Mkt-RF                                  -0.293050
SMB                                     -0.161875
HML                                     -0.028837

        AQR Risk-Balanced Commodities Strategy I (ARCIX)  \
Mkt-RF                                          0.436298
SMB                                            -0.198439
HML                                             0.385313

        AQR Style Premia Alternative I (QSPIX)  \
Mkt-RF                                0.028831
SMB                                  -0.406157
HML                                   0.536513

        Bitcoin Market Price USD (^BTC)  Invesco DB US Dollar Bullish (UUP)  \
Mkt-RF                         1.756685                           -0.172204
SMB                           -0.516295                            0.070058
HML                           -0.343898                           -0.023386

        PIMCO 25+ Year Zero Coupon US Trs ETF (ZROZ)  \
Mkt-RF                                      0.127749
SMB                                        -0.009423
```

```
HML                                              -0.628553

         ProShares VIX Mid-Term Futures (VIXM)  \
Mkt-RF                                 -1.375098
SMB                                     0.084818
HML                                    -0.419645

         Vanguard LifeStrategy Income Fund (VASIX)  \
Mkt-RF                                          0.270746
SMB                                            -0.009690
HML                                            -0.055494

         Vanguard Total World Stock ETF (VT)  iShares Gold Trust (IAU)
Mkt-RF                              0.926904                  0.105052
SMB                                -0.045200                 -0.281462
HML                                 0.069572                 -0.094277
```

[7]:

```
# Visualize the beta exposures for all assets
all_betas.T.plot(kind='bar', figsize=(14, 8))
plt.title('Fama-French Factor Exposures for All Assets')
plt.xlabel('Assets')
plt.ylabel('Beta Coefficients (Exposure)')
plt.xticks(rotation=45)
plt.legend(title='Factors')

# Display the plot
plt.show()
```




Betas ( 1, 2, 3) : These represent the asset's sensitivity to each factor.

A high 1 (market) means the asset is strongly correlated with market movements. A positive 2 (SMB) means the asset has small-cap exposure. A positive 3 (HML) means the asset has exposure to value stocks.

```
[ ]:
```

```
[ ]:
```

**References**


Agresti, Alan, and Maria Kateri. Foundations of Statistics for Data Scientists: With R and Python. CRC Press, Taylor & Francis Group, 2022.

Agresti, Alan, and Maria Kateri. (2022) Appendix B2. Chapter 2: Python for Probability Distributions. In Foundations of Statistics for Data Scientists: With R and Python (p. 385-389). CRC Press, Taylor & Francis Group, 2022.

ChatGPT, (2024) GPT-4o version, OpenAI. [Large language model]. https://chatgpt.com/

Opportuinty Dataset - need link/website info

Fama French Factors , Kenneth French's website. http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_

```
[ ]:
```