Lecture 7: MPT Backtestings

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1 Out-of-sample performance of optimal portfolios

1.1 Import and subset data

We will now conduct backtestings to gauge the out-of-sample performance of optimal portfolios.

[1]:

```
import numpy as np
import pandas as pd
import pandas_datareader as pdr
from numpy.linalg import inv
import matplotlib.pyplot as plt
from scipy.optimize import minimize
import seaborn as sns
cmap = sns.color_palette()

factor = pdr.get_data_famafrench('F-F_Research_Data_Factors', start='1-1-1926')
asset = pdr.get_data_famafrench('10_Industry_Portfolios', start='1-1-1926')

start_year = '1980'
end_year = '2021'

df_FF = factor[0].loc[start_year:end_year]
df_R = asset[0].loc[start_year:end_year]
df_ER = df_R.subtract(df_FF.RF,axis=0).shift(1) # lag the data one month
```

1.2 Define useful functions

We need to compute GMVP, MSRP, and strategy returns every month. It will be more convenient to pre-define these functions.

[2]:

```
def gmvp(S):
    ONE = np.ones(len(S))
    return (inv(S) @ ONE) / (ONE.T @ inv(S) @ ONE)

def msrp(ER, S):
    ONE = np.ones(len(S))
    return (inv(S) @ ER) / (ONE.T @ inv(S) @ ER)
```

```
def pret(w, R):
    return (w @ R)
```

1.3 Compute optimal portfolios

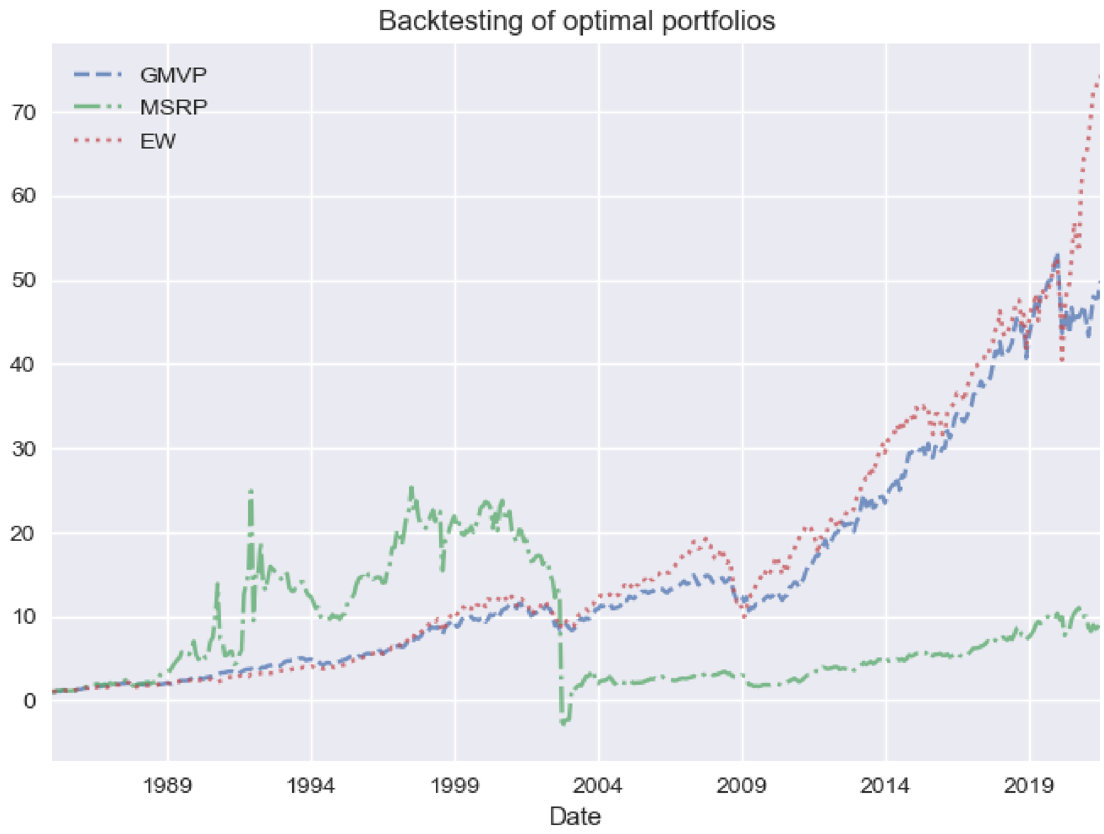
[3]:

```
WSize = 60
AvgER_rolling = df_ER.rolling(WSize).mean()
CovER_rolling = df_ER.rolling(WSize).cov()

Backtest_R = pd.DataFrame(index=df_R.index,columns=['GMVP','MSRP','EW'])

for d in df_ER.index:
    ER = AvgER_rolling.loc[d]
    S = CovER_rolling.loc[d]
    R = df_R.loc[d]
    Backtest_R.loc[d,'GMVP'] = pret(gmvp(S), R)
    Backtest_R.loc[d,'MSRP'] = pret(msrp(ER, S), R)

Backtest_R.loc[:,'EW'] = df_R.mean(axis=1)
Backtest_R = Backtest_R.loc[(df_R.index[0] + WSize):]
```

1.4 Plotting cumulative strategy returns

[4]:

```
plt.style.use('seaborn')
CumRet = (1 + Backtest_R.divide(100)).cumprod()
CumRet['GMVP'].plot(alpha=0.75, linestyle="--")
CumRet['MSRP'].plot(alpha=0.75, linestyle="-.")
CumRet['EW'].plot(alpha=0.75, linestyle=":")
plt.legend()
plt.title('Backtesting of optimal portfolios')
plt.show()
```


Backtesting of optimal portfolios
GMVP
MSRP
EW
70
60
50
40
30
20
10
0
1989
1994
1999
2004
2009
2014
2019
Date