Fama-French Factors (Python)

Based on the SAS based research application, this Python code replicates Fama and French's (1993) methodology to construct size and value factors.

Background

This set of Python code is written based on the original SAS code that replicates the Fama French risk factors SMB and HML. Please refer to the original Fama-French Factors page for detailed discussion on methodology. The flow of the code and the dataset naming convention mimics the SAS code for easy cross-reference.

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Technical Requirement

This code makes use of the Python `wrds` module, a freely-available Python package that WRDS has developed that allows for easy connectivity to our data from within your Python program. The `wrds` module is available both on our high-performance computing cluster, the WRDS Cloud, and on your local workstation. Please see the below documentation for instructions on setting up your Python environment from either location to be able to connect to WRDS. Once set up, you can then run the Python code presented on this page.

- PYTHON: On the WRDS Cloud
- PYTHON: From Your Computer (Jupyter/Spyder)

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Fama French Factors Python Sample Code

```
##########################################
```

```
# Fama French Factors
# April 2018
# Qingyi (Freda) Song Drechsler
##########################################

import pandas as pd
import numpy as np
import datetime as dt
import wrds
import psycopg2
import matplotlib.pyplot as plt
from dateutil.relativedelta import *
from pandas.tseries.offsets import *
from scipy import stats

###################
# Connect to WRDS #
###################
conn=wrds.Connection()

###################
# Compustat Block #
###################
comp = conn.raw_sql("""
                    select gvkey, datadate, at, pstkl, txditc,
                    pstkrv, seq, pstk
                    from comp.funda
                    where indfmt='INDL'
                    and datafmt='STD'
                    and popsrc='D'
                    and consol='C'
                    and datadate >= '01/01/1959'
                    """)

comp['datadate']=pd.to_datetime(comp['datadate']) #convert datadate to date fmt
comp['year']=comp['datadate'].dt.year

# create preferrerd stock
comp['ps']=np.where(comp['pstkrv'].isnull(), comp['pstkl'], comp['pstkrv'])
comp['ps']=np.where(comp['ps'].isnull(),comp['pstk'], comp['ps'])
comp['ps']=np.where(comp['ps'].isnull(),0,comp['ps'])

comp['txditc']=comp['txditc'].fillna(0)

# create book equity
comp['be']=comp['seq']+comp['txditc']-comp['ps']
comp['be']=np.where(comp['be']>0, comp['be'], np.nan)

# number of years in Compustat
comp=comp.sort_values(by=['gvkey','datadate'])
comp['count']=comp.groupby(['gvkey']).cumcount()

comp=comp[['gvkey','datadate','year','be','count']]

###################
# CRSP Block      #
###################
# sql similar to crspmerge macro
crsp_m = conn.raw_sql("""
                      select a.permno, a.permco, a.date, b.shrcd, b.exchcd,
                      a.ret, a.retx, a.shrout, a.prc
                      from crsp.msf as a
                      left join crsp.msenames as b
                      on a.permno=b.permno
                      and b.namedt<=a.date
                      and a.date<=b.nameendt
                      where a.date between '01/01/1959' and '12/31/2017'
                      and b.exchcd between 1 and 3
                      """)

# change variable format to int
crsp_m[['permco','permno','shrcd','exchcd']]=crsp_m[['permco','permno','shrcd','exchcd']].ast


# Line up date to be end of month
crsp_m['date']=pd.to_datetime(crsp_m['date'])
crsp_m['jdate']=crsp_m['date']+MonthEnd(0)

# add delisting return
dlret = conn.raw_sql("""
                     select permno, dlret, dlstdt
                     from crsp.msedelist
                     """)
dlret.permno=dlret.permno.astype(int)
dlret['dlstdt']=pd.to_datetime(dlret['dlstdt'])
dlret['jdate']=dlret['dlstdt']+MonthEnd(0)

crsp = pd.merge(crsp_m, dlret, how='left',on=['permno','jdate'])
crsp['dlret']=crsp['dlret'].fillna(0)
crsp['ret']=crsp['ret'].fillna(0)
crsp['retadj']=(1+crsp['ret'])*(1+crsp['dlret'])-1
crsp['me']=crsp['prc'].abs()*crsp['shrout'] # calculate market equity
crsp=crsp.drop(['dlret','dlstdt','prc','shrout'], axis=1)
crsp=crsp.sort_values(by=['jdate','permco','me'])

### Aggregate Market Cap ###
# sum of me across different permno belonging to same permco a given date
crsp_summe = crsp.groupby(['jdate','permco'])['me'].sum().reset_index()
# largest mktcap within a permco/date
crsp_maxme = crsp.groupby(['jdate','permco'])['me'].max().reset_index()
# join by jdate/maxme to find the permno
crsp1=pd.merge(crsp, crsp_maxme, how='inner', on=['jdate','permco','me'])
# drop me column and replace with the sum me
crsp1=crsp1.drop(['me'], axis=1)
# join with sum of me to get the correct market cap info
crsp2=pd.merge(crsp1, crsp_summe, how='inner', on=['jdate','permco'])
# sort by permno and date and also drop duplicates
crsp2=crsp2.sort_values(by=['permno','jdate']).drop_duplicates()

# keep December market cap
crsp2['year']=crsp2['jdate'].dt.year
crsp2['month']=crsp2['jdate'].dt.month
decme=crsp2[crsp2['month']==12]
decme=decme[['permno','date','jdate','me','year']].rename(columns={'me':'dec_me'})

### July to June dates
crsp2['ffdate']=crsp2['jdate']+MonthEnd(-6)
crsp2['ffyear']=crsp2['ffdate'].dt.year
crsp2['ffmonth']=crsp2['ffdate'].dt.month
crsp2['1+retx']=1+crsp2['retx']
crsp2=crsp2.sort_values(by=['permno','date'])

# cumret by stock
crsp2['cumretx']=crsp2.groupby(['permno','ffyear'])['1+retx'].cumprod()
# lag cumret
crsp2['lcumretx']=crsp2.groupby(['permno'])['cumretx'].shift(1)
```

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# lag market cap
crsp2['lme']=crsp2.groupby(['permno'])['me'].shift(1)

# if first permno then use me/(1+retx) to replace the missing value
crsp2['count']=crsp2.groupby(['permno']).cumcount()
crsp2['lme']=np.where(crsp2['count']==0, crsp2['me']/crsp2['1+retx'], crsp2['lme'])

# baseline me
mebase=crsp2[crsp2['ffmonth']==1][['permno','ffyear', 'lme']].rename(columns=
{'lme':'mebase'})

# merge result back together
crsp3=pd.merge(crsp2, mebase, how='left', on=['permno','ffyear'])
crsp3['wt']=np.where(crsp3['ffmonth']==1, crsp3['lme'], crsp3['mebase']*crsp3['lcumretx'])

decme['year']=decme['year']+1
decme=decme[['permno','year','dec_me']]

# Info as of June
crsp3_jun = crsp3[crsp3['month']==6]

crsp_jun = pd.merge(crsp3_jun, decme, how='inner', on=['permno','year'])
crsp_jun=crsp_jun[['permno','date', 'jdate',
'shrcd','exchcd','retadj','me','wt','cumretx','mebase','lme','dec_me']]
crsp_jun=crsp_jun.sort_values(by=['permno','jdate']).drop_duplicates()

#######################
# CCM Block           #
#######################
ccm=conn.raw_sql("""
                  select gvkey, lpermno as permno, linktype, linkprim,
                  linkdt, linkenddt
                  from crsp.ccmxpf_linktable
                  where substr(linktype,1,1)='L'
                  and (linkprim ='C' or linkprim='P')
                  """)

ccm['linkdt']=pd.to_datetime(ccm['linkdt'])
ccm['linkenddt']=pd.to_datetime(ccm['linkenddt'])
# if linkenddt is missing then set to today date
ccm['linkenddt']=ccm['linkenddt'].fillna(pd.to_datetime('today'))

ccm1=pd.merge(comp[['gvkey','datadate','be', 'count']],ccm,how='left',on=['gvkey'])
ccm1['yearend']=ccm1['datadate']+YearEnd(0)
ccm1['jdate']=ccm1['yearend']+MonthEnd(6)

# set link date bounds
ccm2=ccm1[(ccm1['jdate']>=ccm1['linkdt'])&(ccm1['jdate']<=ccm1['linkenddt'])]
ccm2=ccm2[['gvkey','permno','datadate','yearend', 'jdate','be', 'count']]

# link comp and crsp
ccm_jun=pd.merge(crsp_jun, ccm2, how='inner', on=['permno', 'jdate'])
ccm_jun['beme']=ccm_jun['be']*1000/ccm_jun['dec_me']

# select NYSE stocks for bucket breakdown
# exchcd = 1 and positive beme and positive me and shrcd in (10,11) and at least 2 years
in comp
nyse=ccm_jun[(ccm_jun['exchcd']==1) & (ccm_jun['beme']>0) & (ccm_jun['me']>0) &
(ccm_jun['count']>1) & ((ccm_jun['shrcd']==10) | (ccm_jun['shrcd']==11))]
# size breakdown
nyse_sz=nyse.groupby(['jdate'])['me'].median().to_frame().reset_index().rename(columns=
{'me':'sizemedn'})
```

```
# beme breakdown
nyse_bm=nyse.groupby(['jdate'])['beme'].describe(percentiles=[0.3, 0.7]).reset_index()
nyse_bm=nyse_bm[['jdate','30%','70%']].rename(columns={'30%':'bm30', '70%':'bm70'})

nyse_breaks = pd.merge(nyse_sz, nyse_bm, how='inner', on=['jdate'])
# join back size and beme breakdown
ccm1_jun = pd.merge(ccm_jun, nyse_breaks, how='left', on=['jdate'])


# function to assign sz and bm bucket
def sz_bucket(row):
    if row['me']==np.nan:
        value=''
    elif row['me']<=row['sizemedn']:
        value='S'
    else:
        value='B'
    return value

def bm_bucket(row):
    if 0<=row['beme']<=row['bm30']:
        value = 'L'
    elif row['beme']<=row['bm70']:
        value='M'
    elif row['beme']>row['bm70']:
        value='H'
    else:
        value=''
    return value

# assign size portfolio
ccm1_jun['szport']=np.where((ccm1_jun['beme']>0)&(ccm1_jun['me']>0)&
(ccm1_jun['count']>=1), ccm1_jun.apply(sz_bucket, axis=1), '')
# assign book-to-market portfolio
ccm1_jun['bmport']=np.where((ccm1_jun['beme']>0)&(ccm1_jun['me']>0)&
(ccm1_jun['count']>=1), ccm1_jun.apply(bm_bucket, axis=1), '')
# create positivebmeme and nonmissport variable
ccm1_jun['posbm']=np.where((ccm1_jun['beme']>0)&(ccm1_jun['me']>0)&(ccm1_jun['count']>=1),
1, 0)
ccm1_jun['nonmissport']=np.where((ccm1_jun['bmport']!=''), 1, 0)

# store portfolio assignment as of June
june=ccm1_jun[['permno','date', 'jdate', 'bmport','szport','posbm','nonmissport']]
june['ffyear']=june['jdate'].dt.year

# merge back with monthly records
crsp3 =
crsp3[['date','permno','shrcd','exchcd','retadj','me','wt','cumretx','ffyear','jdate']]
ccm3=pd.merge(crsp3,
        june[['permno','ffyear','szport','bmport','posbm','nonmissport']], how='left', on=
['permno','ffyear'])

# keeping only records that meet the criteria
ccm4=ccm3[(ccm3['wt']>0)& (ccm3['posbm']==1) & (ccm3['nonmissport']==1) &
          ((ccm3['shrcd']==10) | (ccm3['shrcd']==11))]

############################
# Form Fama French Factors #
############################

# function to calculate value weighted return
def wavg(group, avg_name, weight_name):
    d = group[avg_name]
    w = group[weight_name]
    try:
        return (d * w).sum() / w.sum()
    except ZeroDivisionError:
        return np.nan

# value-weigthed return
vwret=ccm4.groupby(['jdate','szport','bmport']).apply(wavg,
'retadj','wt').to_frame().reset_index().rename(columns={0: 'vwret'})
vwret['sbport']=vwret['szport']+vwret['bmport']

# firm count
vwret_n=ccm4.groupby(['jdate','szport','bmport'])
['retadj'].count().reset_index().rename(columns={'retadj':'n_firms'})
vwret_n['sbport']=vwret_n['szport']+vwret_n['bmport']

# tranpose
ff_factors=vwret.pivot(index='jdate', columns='sbport', values='vwret').reset_index()
ff_nfirms=vwret_n.pivot(index='jdate', columns='sbport', values='n_firms').reset_index()

# create SMB and HML factors
ff_factors['WH']=(ff_factors['BH']+ff_factors['SH'])/2
ff_factors['WL']=(ff_factors['BL']+ff_factors['SL'])/2
ff_factors['WHML'] = ff_factors['WH']-ff_factors['WL']

ff_factors['WB']=(ff_factors['BL']+ff_factors['BM']+ff_factors['BH'])/3
ff_factors['WS']=(ff_factors['SL']+ff_factors['SM']+ff_factors['SH'])/3
ff_factors['WSMB'] = ff_factors['WS']-ff_factors['WB']
ff_factors=ff_factors.rename(columns={'jdate':'date'})

# n firm count
ff_nfirms['H']=ff_nfirms['SH']+ff_nfirms['BH']
ff_nfirms['L']=ff_nfirms['SL']+ff_nfirms['BL']
ff_nfirms['HML']=ff_nfirms['H']+ff_nfirms['L']

ff_nfirms['B']=ff_nfirms['BL']+ff_nfirms['BM']+ff_nfirms['BH']
ff_nfirms['S']=ff_nfirms['SL']+ff_nfirms['SM']+ff_nfirms['SH']
ff_nfirms['SMB']=ff_nfirms['B']+ff_nfirms['S']
ff_nfirms['TOTAL']=ff_nfirms['SMB']
ff_nfirms=ff_nfirms.rename(columns={'jdate':'date'})
```

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Outcome Discussion

We compare the output from the Python code with the one from the Fama-French Factors database, and the results are very close.

```
###################
# Compare With FF #
###################
_ff = conn.get_table(library='ff', table='factors_monthly')
_ff=_ff[['date','smb','hml']]
_ff['date']=_ff['date']+MonthEnd(0)

_ffcomp = pd.merge(_ff, ff_factors[['date','WSMB','WHML']], how='inner', on=['date'])
_ffcomp70=_ffcomp[_ffcomp['date']>='01/01/1970']
print(stats.pearsonr(_ffcomp70['smb'], _ffcomp70['WSMB']))
print(stats.pearsonr(_ffcomp70['hml'], _ffcomp70['WHML']))
```

The table below lists the correlation between the Python series of SMB and HML with the Fama French factors respectively, for the sample period of 1970 onwards.

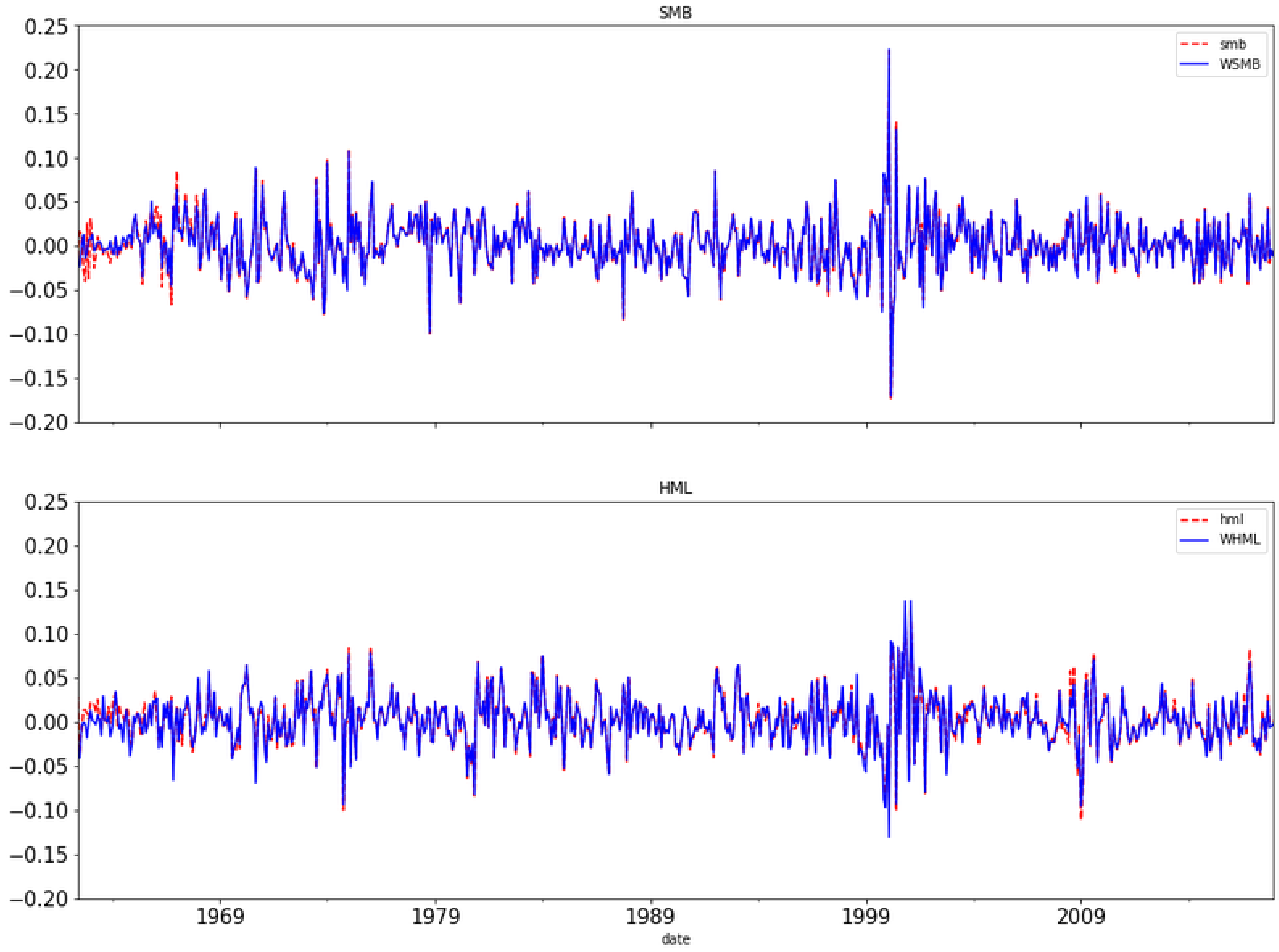
	Correlation

	Correlation
	Correlation
SMB	99.6%
HML	98.1%

Including the earlier sample slightly decreases the correlation as Fama French adopted sources other than CRSP and Compustat for the earlier sample when calculating the original series.

Lastly, we present the figure below which compares the entire series of factors. Solid blue line represents the risk factor generated from the Python code, and dash red line represents the original data series from Fama French library.

Comparison of Results



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