Final Project: Construct Momentum Strategy
Due 12/8/2020 (Tuesday)

Replicates Jegadeesh and Titman (Journal of Finance, 1993) Momentum Portfolios

Jegadeesh and Titman (1993):

- Long-short portfolio based on past return sort yields positive abnormal profits
- Firms that have had high (low) returns in the previous year tend to have high (low) returns in the few subsequent months

Explanations for momentum:

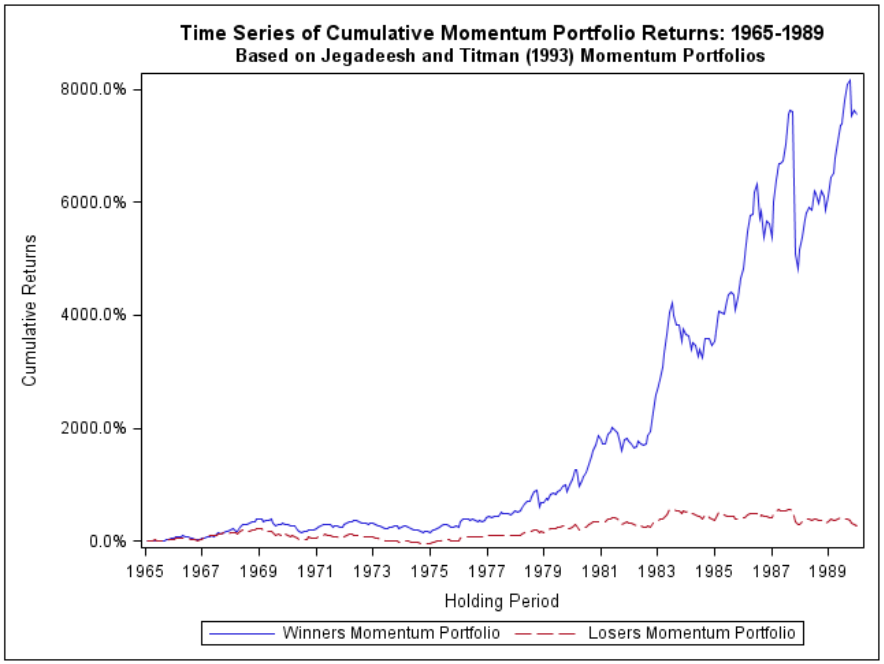
- Behavioral: investor under-reaction (Hong and Stein, 1997; Barberis, Shleifer and Vishney, 1998)
- Rational: growth opportunity (Sagi and Seasholes, 2006) and financial distress cost (Garlappi and Yan, 2011)

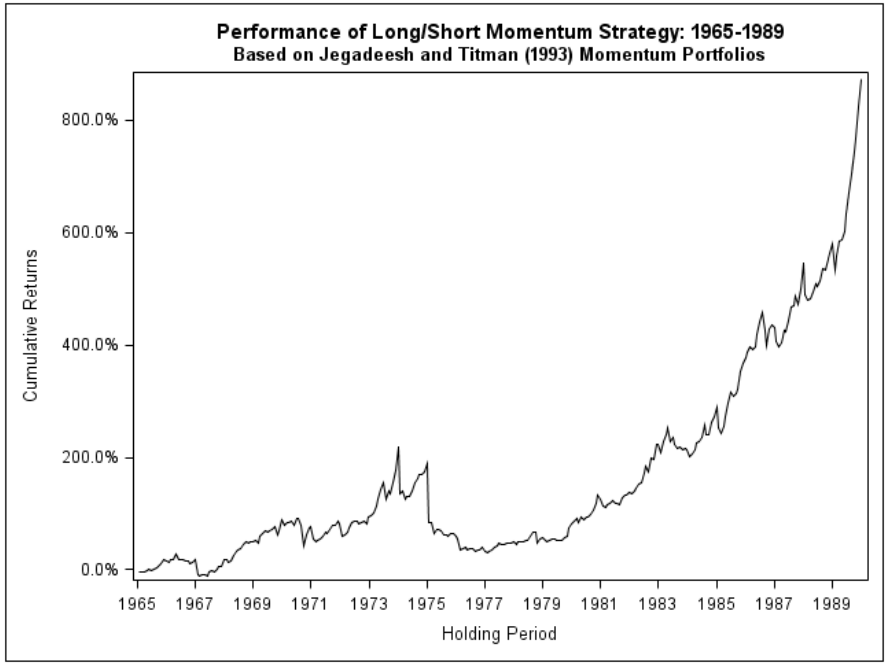
- Read stock monthly return data (I will provide the required data to you.)
  - Include NYSE and AMEX common stocks from Jan. 2000 to Dec. 2020
  - Columns: Date, Permno (stock identifier, each stock has its own unique permno), Ret (stock monthly return)
- Construct Momentum characteristic (signal) based on past 12 Month Compounded Returns (for each stock at each month)
  - E.g, signal at month t: cumulative return from t-J to t
  - cum_ret = (1+r1)x(1+r2)x(1+r3)x…x(1+r12)
- Form 10 Momentum portfolios every month (Details in the following page)
- Form Long-short portfolio (portfolio 10 – portfolio 1).
- Calculate portfolio average monthly returns for 11 portfolios.
- Measure long-short portfolio performance (e.g., standard deviation, sharpe ratio, treynor ratio, max dropdown)
- Calculate Jensens' alpha for long-short portfolio by running the following regression

$$r_P = \alpha_P + \beta_M(r_M - r_F) + \beta_{SMB}\, SMB + \beta_{HML} HML$$

- **Write a report to show your work (including tables, figures, your analysis, and code)**
- Re-construct momentum strategy based on different momentum signals (e.g., based on past 1-month, 6-month, 24-month compounded returns). What do you find?

Example tables & figures (you can design your own outputs)





	1	2	3	4	5	6	7	8	9	10	10–1
					Jan 1966 – Dec 1999						
CAPM alpha	-5.16	-1.88	-0.66	-0.07	-1.48	1.48	1.22	1.38	1.68	1.24	6.40
	(-2.57)	(-1.24)	(-0.56)	(-0.08)	(-1.80)	(1.93)	(1.52)	(1.72)	(1.93)	(1.01)	(2.54)

Momentum Signal Formation

- At the end of each month t, compute the recent return $r_{t-1,t-m}$ for each stock.
- Sort stocks by their recent returns.
- Identify the top *10*% (winners) and bottom *10*% (losers) according to the recent return sort. (10 portfolios with the same number of stocks).
- For each month, calculate the equally-weighted average stock return for each portfolio as its portfolio return.
- Take a long position in the high-return group and a short position in the low-return group (long-short portfolio). Therefore the long-short portfolio return is equal to winner portfolio return – loser portfolio return.
- Hold the 11 portfolios for the **next 1 month** and record the returns.
  - Make sure you calculate the momentum signal at month t, calculate the portfolio returns at month t+1. (You trade stocks based on information before time t, and hold portfolios during the next month t+1).
- Repeat the previous steps. (Form signal at month t+1, hold portfolios during month t+2)

Useful SAS and Python functions (R and MATLAB are similar to Python, you can find similar functions)

SAS: (You can find SAS online documentation for each function)

Calculate cumulative returns (J denote how many past months).

```
proc expand data=return_data (keep=permno date ret) out=umd method=none;
        by permno;
        id date;
        convert ret=cum_return / transformin=(+1) transformout=(MOVPROD &J -1
                trimleft &J);
        quit;
```

To calculate 12-month cumulative returns, change &J to 12

Rank stocks based on signal (fill "?"), notice that we need to sort data by date first before calling proc rank function. We'd like to rank stocks for each date (month)

```
proc sort data=umd;
        by date;
run;
proc rank data=umd out=umd group=?;
        by ?;
        var ?;
        ranks momr;
run;
```

Denote holding period (next 1 month) (fill "?", search function "intnx", what is HDATE1 and HDATE2?)

```
data umd;
	set umd (drop=cum_return);
	where momr>=0;
	momr=momr+1;
	HDATE1=intnx("MONTH", date, ?, "B");
	HDATE2=intnx("MONTH", date, ?, "E");
	rename date=form_date;
run;
```

After calculating trading signal, next we need to calculate portfolio returns in the next month. Here, I merge stock monthly return data with trading signal data (umd) (search "proc sql", what's meaning of the following function? Basically, I merge the rows in umd and return_data by requiring they have the same "permno" and date in return_data is between HDATE1 and HDATE2 in umd, why?)

```
proc sql;
	create table umd2 as select distinct a.momr, a.form_date, a.permno, b.date,
		b.ret from umd as a, return_data as b where a.permno=b.permno and
		a.HDATE1<=b.date<=a.HDATE2;
quit;
proc sort data=umd2 nodupkey;
	by date momr form_date permno;
run;
```

Calculating equally-weighted returns across portfolio stocks

```
proc means data=umd2 noprint;
        by ? ?;
        var ?;
        output out=ewretdat mean=?;
run;
```

Calculating summary statistics for each portfolio

```
proc means data=ewretdat n mean t probt;
        class ?;
        var ?;
run;
```

Calculating Long-Short Portfolio Returns

```
proc transpose data=ewretdat out=ewretdat2
    (rename=(_1=LOSERS _2=PORT2 _3=PORT3 _4=PORT4 _5=PORT5 _6=PORT6
             _7=PORT7 _8=PORT8 _9=PORT9 _10=WINNERS) drop=_NAME_ _LABEL_)
prefix=_;
        by ?;
        id ?;
        var ?;
run;
```

Calculating cumulative returns (hint: you need keyword "retain" in DATA step.)

Calculating alpha:

Regression, some online resources:

(https://documentation.sas.com/?cdcId=pgmsascdc&cdcVersion=9.4_3.4&docsetId=statug&docsetTarget=statug_reg_syntax01.htm&locale=en)

(https://documentation.sas.com/?cdcId=pgmsascdc&cdcVersion=9.4_3.3&docsetId=statug&docsetTarget=statug_introreg_sect003.htm&locale=en)

(https://stats.idre.ucla.edu/sas/dae/multivariate-regression-analysis/)

```
proc reg data=?;
  model ?;
run;
```

Python: (You can find Python online documentation for each function)

Calculate cumulative returns (J denote how many past months).

```
_tmp_crsp = return_data[['permno','date','ret']].sort_values(['permno','date'])\
    .set_index('date')
_tmp_crsp['ret']=_tmp_crsp['ret'].fillna(0)
_tmp_crsp['logret']=np.log(1+_tmp_crsp['ret'])
umd = _tmp_crsp.groupby(['permno'])['logret'].rolling(J, min_periods=J).sum()
umd = umd.reset_index()
umd['cumret']=np.exp(umd['logret'])-1
```

Rank stocks based on signal (fill "?") We'd like to rank stocks for each date (month)

```
umd=umd.dropna(?)
umd['momr']=umd.groupby(?)[?].transform(lambda x: pd.qcut(x, ?, labels=False))
```

Denote holding period (next 1 month) (fill "?", what is medate, HDATE1 and HDATE2?)

```
umd['form_date'] = umd['date']
umd['medate'] = umd['date']+MonthEnd(0)
umd['hdate1']=umd['medate']+ MonthEnd(?)
umd['hdate2']=umd['medate']+MonthEnd(?)
umd = umd[['permno', 'form_date','momr','hdate1','hdate2']]
```

After calculating trading signal, next we need to calculate portfolio returns in the next month. Here, I merge stock monthly return data with trading signal data (umd) (What's meaning of the following function? Basically, I merge the rows in umd and return_data by requiring they have the same "permno" and date in return_data is between HDATE1 and HDATE2 in umd, why?)

```
_tmp_ret = crsp_m[['permno','date','ret']]
port = pd.merge(_tmp_ret, umd, on=['permno'], how='inner')
port = port[(port[?]<=port['date']) & (port['date']<=port[?])] # this step consumes a lot of memory so takes a while #

umd2 = port.sort_values(by=['date','momr','form_date','permno']).drop_duplicates()
ewret = umd2.groupby(?)[?].mean().reset_index()
```

Calculating Long-Short Portfolio Returns

```
# Transpose portfolio layout to have columns as portfolio returns
ewretdat2 = ewretdat.pivot(index=?, columns=?, values=?)

ewretdat3['cumret_long_short']=ewretdat3[?].cumprod()-1
```

Calculating alpha, regression: (https://www.statsmodels.org/stable/index.html)

```
import statsmodels.formula.api as smf
```