BA870 Individual Project

NAME: Jacinto Lemarroy

Import libraries and packages

In [211]:
```
import numpy as np
import pandas as pd
from scipy.stats.mstats import winsorize
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
from statsmodels.sandbox.regression.predstd import wls_prediction_std
```

Step 1: Collect data for your project based on ticker symbols from the Russell 3000 index:

Upload Datasets

In [212]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remoun
t, call drive.mount("/content/drive", force_remount=True).
```

In [213]:
```
data_pt = pd.read_csv('/content/ProjectTickers.csv')
```

In [214]:
```
data_pt.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1886 entries, 0 to 1885
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   Ticker  1886 non-null   object 
 1   Name    1886 non-null   object 
 2   RetYTD  1886 non-null   float64
dtypes: float64(1), object(2)
memory usage: 44.3+ KB
```

In [215]:
```
data_pt.head()
```

Out[215]:

	Ticker	Name	RetYTD
0	A	Agilent Technologies	-0.2080
1	AA	Alcoa Corp	0.4731
2	AAL	American Airlines Gp	0.0579
3	AAN	Aarons Holdings Company	-0.1327
4	AAON	Aaon Inc	-0.3456

In [216]:
```
data_a3 = pd.read_csv("/content/Project-2017-21-Returns.csv")
# data_a3.to_csv('Project-2017-21-Returns.csv', index=False)
```

In [217]:
```
data_a3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 114715 entries, 0 to 114714
Data columns (total 4 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   PERMNO  114715 non-null  int64 
 1   date    114715 non-null  int64 
 2   TICKER  114653 non-null  object
 3   RET     114700 non-null  object
dtypes: int64(2), object(2)
memory usage: 3.5+ MB
```

In [218]:
```
# change RET to numeric to be able to use it in regression
data_a3['RET'] = pd.to_numeric(data_a3['RET'],errors='coerce')
```

In [219]:
```
data_a3.head()
```

Out[219]:

	PERMNO	date	TICKER	RET
0	10026	20170131	JJSF	-0.043918
1	10026	20170228	JJSF	0.048836
2	10026	20170331	JJSF	0.016293
3	10026	20170428	JJSF	-0.007229
4	10026	20170531	JJSF	-0.033289

In [220]:
```
# we see 1925 unique tickers but we have to match it with the ticker dat
a of 1886
len(data_a3.TICKER.unique())
```

Out[220]: 1925

We should join data_pt and data_a3 to get 1886 unique tickers and match it

In [221]:
```
data_a3.rename(columns={'TICKER':'Ticker'}, inplace=True)
data_a3.head(2)
```

Out[221]:

	PERMNO	date	Ticker	RET
0	10026	20170131	JJSF	-0.043918
1	10026	20170228	JJSF	0.048836

In [222]:
```
# now lets merge on ticker on the left
data_a3 = pd.merge(data_pt, data_a3, on = 'Ticker', how ='left')
```

In [223]:
```
# now we have 1886 unique tickers to match the other
len(data_a3.Ticker.unique())
```

Out[223]: 1886

In [224]:
```
data_a4 = pd.read_csv('/content/Project-2021-Financials.csv')
# data_a4.to_csv("Project-2021-Financials.csv", index=False)
```

In [225]:
```
data_a4.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1886 entries, 0 to 1885
Data columns (total 20 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   gvkey     1886 non-null   int64  
 1   datadate  1886 non-null   int64  
 2   fyear     1886 non-null   int64  
 3   indfmt    1886 non-null   object 
 4   consol    1886 non-null   object 
 5   popsrc    1886 non-null   object 
 6   datafmt   1886 non-null   object 
 7   tic       1886 non-null   object 
 8   curcd     1886 non-null   object 
 9   act       1431 non-null   float64
 10  at        1886 non-null   float64
 11  ceq       1886 non-null   float64
 12  csho      1886 non-null   float64
 13  ebit      1886 non-null   float64
 14  lct       1431 non-null   float64
 15  lt        1881 non-null   float64
 16  ni        1886 non-null   float64
 17  sale      1886 non-null   float64
 18  costat    1886 non-null   object 
 19  prcc_c    1886 non-null   float64
dtypes: float64(10), int64(3), object(7)
memory usage: 294.8+ KB
```

In [226]:
```
# deal with null values
# replace liabilities na with mean
data_a4['lt'].fillna(value=data_a4['lt'].mean(), inplace=True)


# delete act and lct since too many na
data_a4.drop(['act', 'lct'], axis = 1, inplace = True)
```

In [227]:
```
data_a4.head()
```

Out[227]:

	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	tic	curcd	at	ceq	
0	1004	20210531	2020	INDL	C	D	STD	AIR	USD	1539.700	974.4	
1	1045	20211231	2021	INDL	C	D	STD	AAL	USD	66467.000	-7340.0	6
2	1075	20211231	2021	INDL	C	D	STD	PNW	USD	22003.222	5906.2	1
3	1078	20211231	2021	INDL	C	D	STD	ABT	USD	75196.000	35802.0	17
4	1161	20211231	2021	INDL	C	D	STD	AMD	USD	12419.000	7497.0	12

In [228]:
```
data_a5 = pd.read_csv('/content/Project-2021-Sector.csv')
# data_a5.to_csv("Project-2021-Sector.csv", index=False)
```

In [229]:
```
data_a5.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1886 entries, 0 to 1885
Data columns (total 11 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   gvkey     1886 non-null   int64 
 1   datadate  1886 non-null   int64 
 2   fyear     1886 non-null   int64 
 3   indfmt    1886 non-null   object
 4   consol    1886 non-null   object
 5   popsrc    1886 non-null   object
 6   datafmt   1886 non-null   object
 7   tic       1886 non-null   object
 8   curcd     1886 non-null   object
 9   costat    1886 non-null   object
 10  ggroup    1886 non-null   int64 
dtypes: int64(4), object(7)
memory usage: 162.2+ KB
```

In [230]:
```
data_a5.head()
```

Out[230]:

	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	tic	curcd	costat	ggroup
0	1004	20210531	2020	INDL	C	D	STD	AIR	USD	A	2010
1	1045	20211231	2021	INDL	C	D	STD	AAL	USD	A	2030
2	1075	20211231	2021	INDL	C	D	STD	PNW	USD	A	5510
3	1078	20211231	2021	INDL	C	D	STD	ABT	USD	A	3510
4	1161	20211231	2021	INDL	C	D	STD	AMD	USD	A	4530

In [231]:
```
data_a5.rename(columns={'tic':'Ticker'}, inplace=True)
data_a5.head()
```

Out[231]:

	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	Ticker	curcd	costat	ggroup
0	1004	20210531	2020	INDL	C	D	STD	AIR	USD	A	2010
1	1045	20211231	2021	INDL	C	D	STD	AAL	USD	A	2030
2	1075	20211231	2021	INDL	C	D	STD	PNW	USD	A	5510
3	1078	20211231	2021	INDL	C	D	STD	ABT	USD	A	3510
4	1161	20211231	2021	INDL	C	D	STD	AMD	USD	A	4530

Step 2: Determine Risk Exposures

Upload Fama-French monthly risk factor data

In [232]:
```
ff_factors = pd.read_csv('/content/FF-Factors-2017-2021.csv')
```

List variables in FF dataframe

In [233]:
```
ff_factors.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 60 entries, 0 to 59
Data columns (total 5 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   dateff  60 non-null     int64  
 1   mktrf   60 non-null     float64
 2   smb     60 non-null     float64
 3   hml     60 non-null     float64
 4   rf      60 non-null     float64
dtypes: float64(4), int64(1)
memory usage: 2.5 KB
```

Look at head and tail of dataframe

In [234]:
```
ff_factors.head()
```

Out[234]:

	dateff	mktrf	smb	hml	rf
0	20170131	0.0194	-0.0113	-0.0274	0.0004
1	20170228	0.0357	-0.0204	-0.0167	0.0004
2	20170331	0.0017	0.0113	-0.0333	0.0003
3	20170428	0.0109	0.0072	-0.0213	0.0005
4	20170531	0.0106	-0.0252	-0.0375	0.0006

In [235]:
```
ff_factors.tail()
```

Out[235]:

	dateff	mktrf	smb	hml	rf
55	20210831	0.0290	-0.0048	-0.0013	0.0000
56	20210930	-0.0437	0.0080	0.0509	0.0000
57	20211029	0.0665	-0.0228	-0.0044	0.0000
58	20211130	-0.0155	-0.0135	-0.0053	0.0000
59	20211231	0.0310	-0.0157	0.0323	0.0001

Rename date column to "date" to match WRDS data "date" column for stock data

In [236]:
```
ff_factors.rename(columns={'dateff':'date'}, inplace=True)
ff_factors.head()
```

Out[236]:

	date	mktrf	smb	hml	rf
0	20170131	0.0194	-0.0113	-0.0274	0.0004
1	20170228	0.0357	-0.0204	-0.0167	0.0004
2	20170331	0.0017	0.0113	-0.0333	0.0003
3	20170428	0.0109	0.0072	-0.0213	0.0005
4	20170531	0.0106	-0.0252	-0.0375	0.0006

Let's create a LOOP that will perform the tasks for each of the 100 stocks

In [237]:
```
# let's create a list of the companies ticker values to loop around it
companies = list(data_a3.Ticker.unique())
print(len(companies))
print(companies)
```

```
1886
['A', 'AA', 'AAL', 'AAN', 'AAON', 'AAP', 'AAPL', 'AAT', 'AAWW', 'ABBV',
'ABC', 'ABCB', 'ABG', 'ABM', 'ABMD', 'ABR', 'ABT', 'ABTX', 'ABUS', 'ACA
D', 'ACC', 'ACCO', 'ACGL', 'ACHC', 'ACIW', 'ACLS', 'ACM', 'ACN', 'ACR
E', 'ACRS', 'ADBE', 'ADC', 'ADI', 'ADM', 'ADNT', 'ADP', 'ADSK', 'ADTN',
'ADUS', 'AEE', 'AEIS', 'AEL', 'AEO', 'AEP', 'AERI', 'AES', 'AFG', 'AF
L', 'AGCO', 'AGEN', 'AGIO', 'AGLE', 'AGNC', 'AGO', 'AGR', 'AGX', 'AGY
S', 'AHH', 'AHT', 'AIG', 'AIMC', 'AIN', 'AIR', 'AIT', 'AIV', 'AIZ', 'AJ
G', 'AJRD', 'AKAM', 'AKBA', 'AKR', 'AL', 'ALB', 'ALBO', 'ALDX', 'ALE',
'ALEX', 'ALG', 'ALGN', 'ALGT', 'ALK', 'ALKS', 'ALL', 'ALLE', 'ALLY', 'A
LNY', 'ALRM', 'ALSN', 'ALX', 'AMAT', 'AMBA', 'AMBC', 'AMC', 'AMCX', 'AM
D', 'AME', 'AMED', 'AMG', 'AMGN', 'AMH', 'AMKR', 'AMN', 'AMNB', 'AMOT',
'AMP', 'AMPE', 'AMPH', 'AMRC', 'AMRK', 'AMRS', 'AMSC', 'AMSF', 'AMSWA',
'AMT', 'AMTX', 'AMWD', 'AMZN', 'AN', 'ANAB', 'ANAT', 'ANDE', 'ANET', 'A
NF', 'ANGO', 'ANIK', 'ANIP', 'ANSS', 'ANTM', 'AON', 'AOS', 'AOSL', 'AP
A', 'APAM', 'APD', 'APEI', 'APH', 'APLE', 'APO', 'APOG', 'APPF', 'APP
S', 'APTS', 'AR', 'ARAY', 'ARCB', 'ARCH', 'ARDX', 'ARE', 'ARES', 'ARI',
'ARMK', 'ARNC', 'AROC', 'AROW', 'ARR', 'ARTNA', 'ARW', 'ARWR', 'ASB',
'ASGN', 'ASH', 'ASIX', 'ASPN', 'ASTE', 'ATEC', 'ATEN', 'ATHX', 'ATI',
'ATKR', 'ATLC', 'ATNI', 'ATO', 'ATOM', 'ATOS', 'ATR', 'ATRA', 'ATRC',
'ATRI', 'ATRO', 'ATRS', 'ATSG', 'ATVI', 'AVA', 'AVAV', 'AVB', 'AVD', 'A
VGO', 'AVID', 'AVNW', 'AVT', 'AVXL', 'AVY', 'AWI', 'AWK', 'AWR', 'AXG
N', 'AXL', 'AXP', 'AXS', 'AXSM', 'AXTA', 'AXTI', 'AYI', 'AZO', 'AZPN',
'AZZ', 'B', 'BA', 'BAC', 'BAH', 'BANC', 'BANF', 'BANR', 'BAX', 'BBBY',
'BBSI', 'BBY', 'BC', 'BCC', 'BCO', 'BCOR', 'BCOV', 'BCPC', 'BCRX', 'BD
C', 'BDN', 'BDX', 'BECN', 'BEN', 'BERY', 'BFAM', 'BFS', 'BG', 'BGCP',
'BGFV', 'BGS', 'BHB', 'BHE', 'BHLB', 'BIG', 'BIIB', 'BJRI', 'BK', 'BK
D', 'BKE', 'BKH', 'BKU', 'BL', 'BLBD', 'BLD', 'BLDR', 'BLFS', 'BLK', 'B
LKB', 'BLL', 'BLMN', 'BLUE', 'BLX', 'BMI', 'BMRC', 'BMRN', 'BMY', 'BNE
D', 'BNFT', 'BOH', 'BOKF', 'BOOM', 'BOOT', 'BOX', 'BPMC', 'BPOP', 'BR',
'BRC', 'BRKL', 'BRKR', 'BRO', 'BRX', 'BSRR', 'BSX', 'BURL', 'BUSE', 'B
W', 'BWA', 'BWXT', 'BX', 'BXC', 'BXMT', 'BXP', 'BYD', 'BZH', 'C', 'CAB
O', 'CAC', 'CACC', 'CACI', 'CAG', 'CAH', 'CAKE', 'CAL', 'CALM', 'CALX',
'CAMP', 'CAR', 'CARA', 'CASH', 'CASS', 'CASY', 'CAT', 'CATO', 'CATY',
'CB', 'CBAY', 'CBOE', 'CBRL', 'CBSH', 'CBT', 'CBU', 'CBZ', 'CC', 'CCB
G', 'CCF', 'CCI', 'CCK', 'CCL', 'CCMP', 'CCNE', 'CCO', 'CCOI', 'CCRN',
'CCS', 'CCXI', 'CDE', 'CDEV', 'CDK', 'CDNA', 'CDNS', 'CDW', 'CDXC', 'CD
XS', 'CE', 'CENTA', 'CENX', 'CERN', 'CERS', 'CEVA', 'CF', 'CFFN', 'CF
G', 'CFR', 'CG', 'CGNX', 'CHCO', 'CHCT', 'CHD', 'CHDN', 'CHE', 'CHEF',
'CHGG', 'CHH', 'CHRS', 'CHRW', 'CHS', 'CHTR', 'CHUY', 'CI', 'CIEN', 'CI
M', 'CINF', 'CIO', 'CIVB', 'CL', 'CLDT', 'CLDX', 'CLF', 'CLFD', 'CLH',
'CLNE', 'CLR', 'CLVS', 'CLW', 'CLX', 'CMA', 'CMC', 'CMCO', 'CMCSA', 'CM
E', 'CMG', 'CMI', 'CMP', 'CMPR', 'CMRE', 'CMRX', 'CMS', 'CMTL', 'CNA',
'CNC', 'CNDT', 'CNK', 'CNMD', 'CNO', 'CNOB', 'CNP', 'CNS', 'CNSL', 'CNT
Y', 'CNX', 'CNXN', 'COF', 'COHR', 'COHU', 'COKE', 'COLB', 'COLL', 'COL
M', 'COMM', 'CONN', 'COO', 'COP', 'CORT', 'COST', 'COTY', 'COUP', 'COW
N', 'CPA', 'CPB', 'CPE', 'CPF', 'CPK', 'CPRT', 'CPRX', 'CPS', 'CPSI',
'CPT', 'CR', 'CRAI', 'CRI', 'CRIS', 'CRK', 'CRL', 'CRM', 'CRMT', 'CRO
X', 'CRS', 'CRUS', 'CRVL', 'CSCO', 'CSGP', 'CSGS', 'CSII', 'CSL', 'CST
M', 'CSTR', 'CSV', 'CSWI', 'CSX', 'CTAS', 'CTBI', 'CTLT', 'CTMX', 'CT
O', 'CTRE', 'CTRN', 'CTS', 'CTSH', 'CTSO', 'CTT', 'CTXS', 'CUBE', 'CUB
I', 'CUTR', 'CUZ', 'CVBF', 'CVCO', 'CVGW', 'CVI', 'CVLT', 'CVM', 'CVS',
'CVX', 'CW', 'CWH', 'CWST', 'CWT', 'CXW', 'CYH', 'CYRX', 'CYTK', 'CZN
C', 'D', 'DAL', 'DAN', 'DAR', 'DBD', 'DCI', 'DCO', 'DDD', 'DDS', 'DE',
'DEA', 'DECK', 'DEI', 'DENN', 'DFIN', 'DFS', 'DG', 'DGII', 'DGX', 'DH
I', 'DHIL', 'DHR', 'DHT', 'DIN', 'DIOD', 'DIS', 'DISH', 'DJCO', 'DK',
'DKS', 'DLB', 'DLR', 'DLTR', 'DLX', 'DMRC', 'DNOW', 'DOC', 'DOOR', 'DOR
```

```
M', 'DOV', 'DOX', 'DPZ', 'DRE', 'DRH', 'DRI', 'DRQ', 'DRRX', 'DTE', 'DU
K', 'DVA', 'DVAX', 'DVN', 'DX', 'DXCM', 'DXPE', 'DY', 'DZSI', 'EA', 'EA
T', 'EBAY', 'EBF', 'EBIX', 'EBS', 'EBTC', 'ECL', 'ECOL', 'ECOM', 'ECP
G', 'ED', 'EDIT', 'EEFT', 'EFC', 'EFSC', 'EFX', 'EGAN', 'EGBN', 'EGHT',
'EGLE', 'EGP', 'EGRX', 'EHTH', 'EIG', 'EIX', 'EL', 'ELF', 'ELS', 'ELY',
'EME', 'EMKR', 'EMN', 'EMR', 'ENDP', 'ENPH', 'ENR', 'ENS', 'ENSG', 'ENT
A', 'ENTG', 'ENV', 'ENVA', 'EOG', 'EPAM', 'EPAY', 'EPC', 'EPR', 'EPZM',
'EQBK', 'EQC', 'EQIX', 'EQR', 'EQT', 'ERIE', 'ERII', 'ES', 'ESE', 'ESG
R', 'ESNT', 'ESPR', 'ESRT', 'ESS', 'ESTE', 'ETN', 'ETR', 'ETSY', 'EVB
G', 'EVC', 'EVH', 'EVR', 'EVRI', 'EVTC', 'EW', 'EWBC', 'EXAS', 'EXC',
'EXEL', 'EXLS', 'EXP', 'EXPD', 'EXPE', 'EXPO', 'EXR', 'EXTR', 'EZPW',
'F', 'FAF', 'FANG', 'FARO', 'FAST', 'FATE', 'FB', 'FBC', 'FBHS', 'FBK',
'FBMS', 'FBNC', 'FBP', 'FC', 'FCBC', 'FCEL', 'FCF', 'FCFS', 'FCN', 'FCN
CA', 'FCPT', 'FCX', 'FDP', 'FDS', 'FDX', 'FE', 'FELE', 'FFBC', 'FFIC',
'FFIN', 'FFIV', 'FFWM', 'FGEN', 'FHB', 'FHN', 'FIBK', 'FICO', 'FIS', 'F
ISI', 'FISV', 'FITB', 'FIVE', 'FIVN', 'FIX', 'FIZZ', 'FL', 'FLGT', 'FLI
C', 'FLL', 'FLO', 'FLR', 'FLS', 'FLT', 'FLWS', 'FMBH', 'FMC', 'FMNB',
'FN', 'FNB', 'FNF', 'FNLC', 'FOE', 'FOLD', 'FORM', 'FORR', 'FOSL', 'FOX
A', 'FOXF', 'FPI', 'FR', 'FRC', 'FRME', 'FRO', 'FRPT', 'FRT', 'FSLR',
'FSP', 'FSS', 'FTNT', 'FTV', 'FUL', 'FULT', 'FWONK', 'FWRD', 'G', 'GAB
C', 'GATX', 'GBCI', 'GBT', 'GBX', 'GCO', 'GCP', 'GD', 'GDDY', 'GDEN',
'GDOT', 'GE', 'GEO', 'GERN', 'GES', 'GEVO', 'GFF', 'GGG', 'GHC', 'GII
I', 'GILD', 'GIS', 'GKOS', 'GLDD', 'GLOB', 'GLPI', 'GLT', 'GLW', 'GM',
'GME', 'GMED', 'GMRE', 'GMS', 'GNK', 'GNL', 'GNRC', 'GNTX', 'GNW', 'GOG
O', 'GOLF', 'GOOD', 'GOOGL', 'GPC', 'GPI', 'GPK', 'GPN', 'GPRE', 'GPR
O', 'GPS', 'GRBK', 'GRC', 'GRMN', 'GRPN', 'GS', 'GSAT', 'GSBC', 'GT',
'GTLS', 'GTY', 'GVA', 'GWRE', 'GWW', 'H', 'HA', 'HAE', 'HAFC', 'HAIN',
'HAL', 'HALO', 'HAS', 'HASI', 'HAYN', 'HBAN', 'HBCP', 'HBI', 'HBIO', 'H
BNC', 'HCA', 'HCCI', 'HCI', 'HCKT', 'HCSG', 'HD', 'HE', 'HEAR', 'HEES',
'HELE', 'HES', 'HFWA', 'HGV', 'HHC', 'HI', 'HIBB', 'HIFS', 'HIG', 'HI
I', 'HIW', 'HL', 'HLF', 'HLI', 'HLIT', 'HLT', 'HLX', 'HMN', 'HMST', 'HN
I', 'HOFT', 'HOG', 'HOLX', 'HOMB', 'HON', 'HONE', 'HOPE', 'HOV', 'HP',
'HPE', 'HPP', 'HPQ', 'HQY', 'HR', 'HRB', 'HRI', 'HRL', 'HRTX', 'HSC',
'HSIC', 'HSII', 'HSKA', 'HST', 'HSTM', 'HSY', 'HT', 'HTA', 'HTBI', 'HTB
K', 'HTH', 'HTLD', 'HTLF', 'HUBB', 'HUBG', 'HUBS', 'HUM', 'HUN', 'HUR
N', 'HWKN', 'HXL', 'HY', 'HZNP', 'HZO', 'IAC', 'IART', 'IBCP', 'IBIO',
'IBKR', 'IBM', 'IBOC', 'IBP', 'IBTX', 'ICAD', 'ICE', 'ICFI', 'ICHR', 'I
CPT', 'ICUI', 'IDA', 'IDCC', 'IDT', 'IDXX', 'IESC', 'IEX', 'IFF', 'IG
T', 'IIIN', 'IIPR', 'IIVI', 'ILMN', 'IMAX', 'IMGN', 'IMKTA', 'INBK', 'I
NCY', 'INDB', 'INFN', 'INFU', 'INGN', 'INGR', 'INN', 'INO', 'INSG', 'IN
SM', 'INSW', 'INT', 'INTC', 'INTU', 'INVA', 'INVE', 'IONS', 'IOSP', 'I
P', 'IPAR', 'IPG', 'IPGP', 'IPI', 'IR', 'IRBT', 'IRDM', 'IRM', 'IRMD',
'IRT', 'IRTC', 'IRWD', 'ISRG', 'IT', 'ITCI', 'ITGR', 'ITRI', 'ITT', 'IT
W', 'IVR', 'IVZ', 'JACK', 'JAZZ', 'JBHT', 'JBL', 'JBLU', 'JBSS', 'JBT',
'JCI', 'JELD', 'JJSF', 'JKHY', 'JLL', 'JNCE', 'JNJ', 'JNPR', 'JOE', 'JO
UT', 'JPM', 'JRVR', 'JWN', 'JYNT', 'K', 'KAI', 'KALU', 'KALV', 'KAMN',
'KAR', 'KBAL', 'KBH', 'KBR', 'KE', 'KELYA', 'KEX', 'KEY', 'KEYS', 'KFR
C', 'KFY', 'KHC', 'KIM', 'KKR', 'KLAC', 'KLIC', 'KMB', 'KMI', 'KMPR',
'KMT', 'KMX', 'KN', 'KNSL', 'KO', 'KODK', 'KOP', 'KOPN', 'KOS', 'KPTI',
'KR', 'KRC', 'KRG', 'KRNY', 'KSS', 'KTOS', 'KURA', 'KW', 'KWR', 'L', 'L
AD', 'LADR', 'LAMR', 'LANC', 'LAND', 'LAZ', 'LBAI', 'LBRDK', 'LC', 'LCI
I', 'LDOS', 'LE', 'LEA', 'LECO', 'LEG', 'LEU', 'LFUS', 'LGIH', 'LGND',
'LH', 'LHCG', 'LII', 'LIND', 'LITE', 'LIVN', 'LKFN', 'LKQ', 'LL', 'LLN
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'ZUMZ']
```

In [238]:
```
# start empty list to add regression results
regression_results = []

# look over each tic in the original dataset
for tic in companies:

        #Create dataframe for each tic monthly data
        tic_data = data_a3[data_a3.Ticker == tic]

        #(a) Merge the stocks returns with the FF Risk Factor data
        merged_df = pd.merge(tic_data, ff_factors, on='date', how='oute
r')

        #(b) Run an OLS regression for each stock using FF 3-Factor mode
l.
        y = merged_df["RET"] - merged_df["rf"]
        X = merged_df[['mktrf' , 'smb' , 'hml']]
        # Use statsmodels
        X = sm.add_constant(X) # adding a constant
        model = sm.OLS(y, X).fit()
        #list regression output
        model.summary()

        #(c) Extract the following output items from the regression resu
lts to a dictionary
        dic = {"TICKER": tic, "mktrf":model.params.mktrf,
            "smb":model.params.smb, "hml":model.params.hml}
        #Append resulting dic values to empty list regression_results
        regression_results.append(dic.copy())
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/tsatools.py:117:
FutureWarning: In a future version of pandas all arguments of concat ex
cept for the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
```

In [239]:
```
# let's look at the updated list with each regression value for each tic
ker
regression_results
```

Out[239]:

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```

In [240]:
```
#(d) Store the above items (TICKER, mktrf, smb, hml) to a row in a dataf
rame.
# let's convert the resulting list of dictionaries to a dataframe
df_ff = pd.DataFrame(regression_results)
```

In [241]:
```
df_ff.isna().sum()
```

Out[241]:
```
TICKER     0
mktrf     11
smb       11
hml       11
dtype: int64
```

In [241]:
```

```

In [242]:
```
# deal with null values by filling with mean and dropping TICKER na
df_ff['mktrf'].fillna(value=df_ff['mktrf'].mean(), inplace=True)
df_ff['smb'].fillna(value=df_ff['smb'].mean(), inplace=True)
df_ff['hml'].fillna(value=df_ff['hml'].mean(), inplace=True)
df_ff.dropna(inplace = True)
```

In [243]:
```
# df_ff.dropna(inplace = True)
```

In [244]:
```
df_ff.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   TICKER  1886 non-null   object 
 1   mktrf   1886 non-null   float64
 2   smb     1886 non-null   float64
 3   hml     1886 non-null   float64
dtypes: float64(3), object(1)
memory usage: 73.7+ KB
```

In [245]:
```
# Final dataframe
df_ff
```

Out[245]:

	TICKER	mktrf	smb	hml
0	A	1.014152	-0.253674	-0.143608
1	AA	1.984149	0.527862	1.924844
2	AAL	1.315550	0.612825	1.248123
3	AAN	1.063239	0.668200	0.315612
4	AAON	0.516779	0.422130	-0.117068
...	...	...	...	...
1881	ZEN	1.026803	1.363839	-0.774104
1882	ZION	1.084739	0.869374	1.151468
1883	ZNGA	0.101034	1.200987	-0.714916
1884	ZTS	0.728418	-0.560814	-0.179065
1885	ZUMZ	1.249317	2.336902	0.499124

1886 rows × 4 columns

In [246]:
```
df_ff.to_csv("FF-Exposures.csv", index=False)
```

Graphs

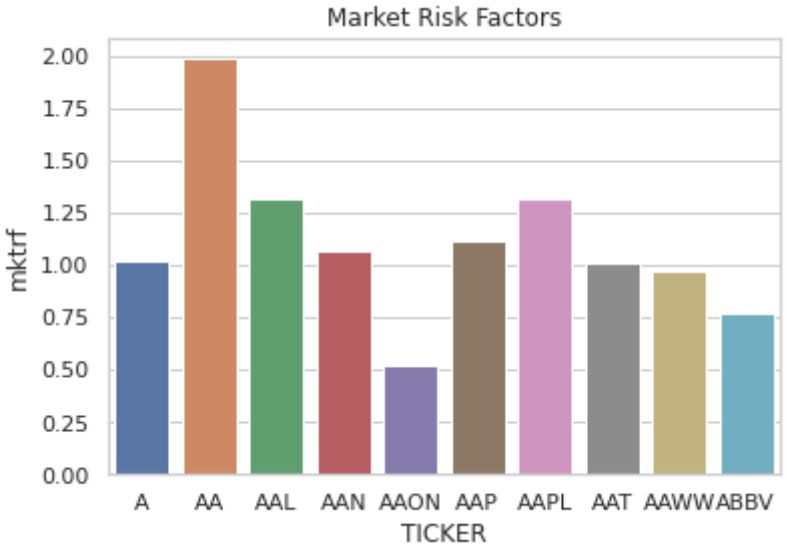
In [247]:
```
df_ff.sort_values(by='mktrf',ascending=True)
```

Out[247]:

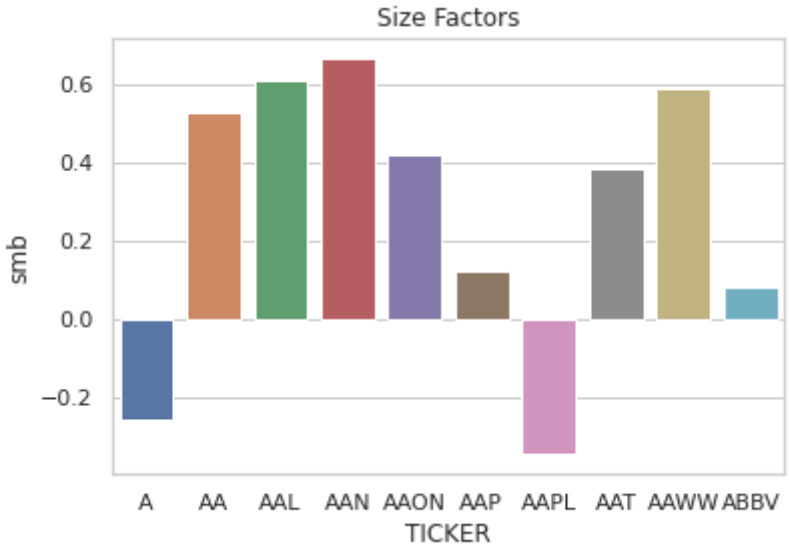
	TICKER	mktrf	smb	hml
745	GME	-6.676723	31.005941	5.919490
868	IBIO	-6.270664	7.711726	-1.560455
114	AMTX	-1.487054	5.469227	2.874999
166	ATHX	-1.272446	1.016641	-2.614146
770	GSAT	-0.799698	4.447946	1.863158
...	...	...	...	...
131	APA	4.189861	1.806118	1.020122
1312	OSTK	4.535825	-0.023182	-1.040776
1559	SM	4.614350	4.826840	2.249215
332	CDEV	5.124663	3.652694	1.991998
986	KODK	6.002016	-6.286219	-0.733014

1886 rows × 4 columns

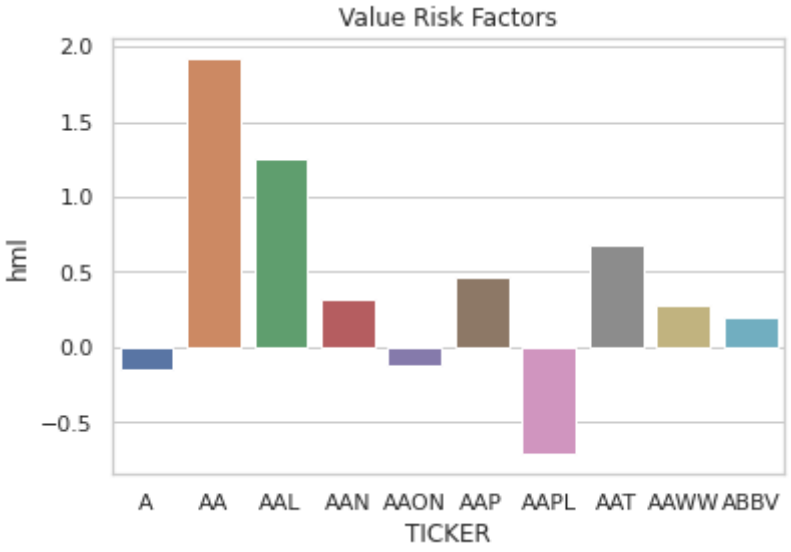
In [248]:
```
# df_ff.mktrf
ff_graph = df_ff.head(10)
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="TICKER", y="mktrf", data=ff_graph).set(title='Market Risk Factors')
```



In [249]:
```
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="TICKER", y="smb", data=ff_graph).set(title='Size Factors')
```



In [250]:
```
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="TICKER", y="hml", data=ff_graph).set(title='Value Risk Factors')
```



Step 3: Calculate Financial Ratios

Examine dataframe

In [251]:
```
data_a4.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1886 entries, 0 to 1885
Data columns (total 18 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   gvkey     1886 non-null   int64  
 1   datadate  1886 non-null   int64  
 2   fyear     1886 non-null   int64  
 3   indfmt    1886 non-null   object 
 4   consol    1886 non-null   object 
 5   popsrc    1886 non-null   object 
 6   datafmt   1886 non-null   object 
 7   tic       1886 non-null   object 
 8   curcd     1886 non-null   object 
 9   at        1886 non-null   float64
 10  ceq       1886 non-null   float64
 11  csho      1886 non-null   float64
 12  ebit      1886 non-null   float64
 13  lt        1886 non-null   float64
 14  ni        1886 non-null   float64
 15  sale      1886 non-null   float64
 16  costat    1886 non-null   object 
 17  prcc_c    1886 non-null   float64
dtypes: float64(8), int64(3), object(7)
memory usage: 265.3+ KB
```

Print out header of dataframe

In [252]:
```
data_a4.head()
```

Out[252]:

	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	tic	curcd	at	ceq	
0	1004	20210531	2020	INDL	C	D	STD	AIR	USD	1539.700	974.4	
1	1045	20211231	2021	INDL	C	D	STD	AAL	USD	66467.000	-7340.0	6
2	1075	20211231	2021	INDL	C	D	STD	PNW	USD	22003.222	5906.2	1
3	1078	20211231	2021	INDL	C	D	STD	ABT	USD	75196.000	35802.0	17
4	1161	20211231	2021	INDL	C	D	STD	AMD	USD	12419.000	7497.0	12

Rename tic column to "Ticker" to match WRDS data "Ticker" column for stock data

In [253]:
```
data_a4.rename(columns={'tic':'Ticker'}, inplace=True)
data_a4.head()
```

Out[253]:

	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	Ticker	curcd	at	ceq
0	1004	20210531	2020	INDL	C	D	STD	AIR	USD	1539.700	974.4
1	1045	20211231	2021	INDL	C	D	STD	AAL	USD	66467.000	-7340.0
2	1075	20211231	2021	INDL	C	D	STD	PNW	USD	22003.222	5906.2
3	1078	20211231	2021	INDL	C	D	STD	ABT	USD	75196.000	35802.0
4	1161	20211231	2021	INDL	C	D	STD	AMD	USD	12419.000	7497.0

Merge datasets

In [254]:
```
merged_df = pd.merge(data_pt, data_a4, on='Ticker', how='inner')
```

In [255]:
```
merged_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 20 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   Ticker    1886 non-null   object 
 1   Name      1886 non-null   object 
 2   RetYTD    1886 non-null   float64
 3   gvkey     1886 non-null   int64  
 4   datadate  1886 non-null   int64  
 5   fyear     1886 non-null   int64  
 6   indfmt    1886 non-null   object 
 7   consol    1886 non-null   object 
 8   popsrc    1886 non-null   object 
 9   datafmt   1886 non-null   object 
 10  curcd     1886 non-null   object 
 11  at        1886 non-null   float64
 12  ceq       1886 non-null   float64
 13  csho      1886 non-null   float64
 14  ebit      1886 non-null   float64
 15  lt        1886 non-null   float64
 16  ni        1886 non-null   float64
 17  sale      1886 non-null   float64
 18  costat    1886 non-null   object 
 19  prcc_c    1886 non-null   float64
dtypes: float64(9), int64(3), object(8)
memory usage: 309.4+ KB
```

In [256]:
```
# examine merged dataset
merged_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 20 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   Ticker     1886 non-null   object 
 1   Name       1886 non-null   object 
 2   RetYTD     1886 non-null   float64
 3   gvkey      1886 non-null   int64  
 4   datadate   1886 non-null   int64  
 5   fyear      1886 non-null   int64  
 6   indfmt     1886 non-null   object 
 7   consol     1886 non-null   object 
 8   popsrc     1886 non-null   object 
 9   datafmt    1886 non-null   object 
 10  curcd      1886 non-null   object 
 11  at         1886 non-null   float64
 12  ceq        1886 non-null   float64
 13  csho       1886 non-null   float64
 14  ebit       1886 non-null   float64
 15  lt         1886 non-null   float64
 16  ni         1886 non-null   float64
 17  sale       1886 non-null   float64
 18  costat     1886 non-null   object 
 19  prcc_c     1886 non-null   float64
dtypes: float64(9), int64(3), object(8)
memory usage: 309.4+ KB
```

In [257]:
```
merged_df.head()
```

Out[257]:

	Ticker	Name	RetYTD	gvkey	datadate	fyear	indfmt	consol	popsrc	datafmt	curc
0	A	Agilent Technologies	-0.2080	126554	20211031	2021	INDL	C	D	STD	US
1	AA	Alcoa Corp	0.4731	27638	20211231	2021	INDL	C	D	STD	US
2	AAL	American Airlines Gp	0.0579	1045	20211231	2021	INDL	C	D	STD	US
3	AAN	Aarons Holdings Company	-0.1327	37445	20211231	2021	INDL	C	D	STD	US
4	AAON	Aaon Inc	-0.3456	21542	20211231	2021	INDL	C	D	STD	US

In [258]:
```
# check dataframe
merged_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 20 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   Ticker     1886 non-null   object 
 1   Name       1886 non-null   object 
 2   RetYTD     1886 non-null   float64
 3   gvkey      1886 non-null   int64  
 4   datadate   1886 non-null   int64  
 5   fyear      1886 non-null   int64  
 6   indfmt     1886 non-null   object 
 7   consol     1886 non-null   object 
 8   popsrc     1886 non-null   object 
 9   datafmt    1886 non-null   object 
 10  curcd      1886 non-null   object 
 11  at         1886 non-null   float64
 12  ceq        1886 non-null   float64
 13  csho       1886 non-null   float64
 14  ebit       1886 non-null   float64
 15  lt         1886 non-null   float64
 16  ni         1886 non-null   float64
 17  sale       1886 non-null   float64
 18  costat     1886 non-null   object 
 19  prcc_c     1886 non-null   float64
dtypes: float64(9), int64(3), object(8)
memory usage: 309.4+ KB
```

In [259]:
```
# check for duplicates
merged_df.duplicated()
```

Out[259]:
```
0       False
1       False
2       False
3       False
4       False
        ...
1881    False
1882    False
1883    False
1884    False
1885    False
Length: 1886, dtype: bool
```

Create Ratios for each stock

In [260]:
```
# first let's create the market value column
merged_df['market_value'] = merged_df.prcc_c * merged_df.csho
```

In [261]:
```
# let's also create other columns that will come in handy
merged_df.rename(columns={"at": "assets"}, inplace=True)
```

In [262]:
```
# check dataframe once more
merged_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 21 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Ticker        1886 non-null   object 
 1   Name          1886 non-null   object 
 2   RetYTD        1886 non-null   float64
 3   gvkey         1886 non-null   int64  
 4   datadate      1886 non-null   int64  
 5   fyear         1886 non-null   int64  
 6   indfmt        1886 non-null   object 
 7   consol        1886 non-null   object 
 8   popsrc        1886 non-null   object 
 9   datafmt       1886 non-null   object 
 10  curcd         1886 non-null   object 
 11  assets        1886 non-null   float64
 12  ceq           1886 non-null   float64
 13  csho          1886 non-null   float64
 14  ebit          1886 non-null   float64
 15  lt            1886 non-null   float64
 16  ni            1886 non-null   float64
 17  sale          1886 non-null   float64
 18  costat        1886 non-null   object 
 19  prcc_c        1886 non-null   float64
 20  market_value  1886 non-null   float64
dtypes: float64(10), int64(3), object(8)
memory usage: 324.2+ KB
```

In [263]:
```
# let's create all the ratios

# market ratios
merged_df['P/E_ratio'] = merged_df['market_value'] / merged_df['ni'] #pr
ice to equity ratio
merged_df['P/S_ratio'] = merged_df['market_value'] / merged_df['sale'] #
price to sales ratio
merged_df['P/B_ratio'] = merged_df['market_value'] / merged_df['ceq'] #p
rice to book ratio
merged_df['P/EBIT_ratio'] = merged_df['market_value'] / merged_df['ebit'
] #price to ebit ratio

# invert the market ratios
merged_df['E/P_ratio'] = 1 / merged_df['P/E_ratio']
merged_df['S/P_ratio'] = 1 / merged_df['P/S_ratio']
merged_df['B/P_ratio'] = 1 / merged_df['P/B_ratio']
merged_df['EBIT/P_ratio'] = 1 / merged_df['P/EBIT_ratio']

# other ratios
merged_df['net_profit_margin'] = merged_df['ni'] / merged_df['sale']
merged_df['debt_ratio'] = merged_df['lt'] / merged_df['assets']
merged_df['roa'] = merged_df['ni'] / merged_df['assets'] #return on asse
ts
merged_df['roe'] = merged_df['ni'] / merged_df['market_value'] #return o
n equity
merged_df['D/E_ratio'] = merged_df['lt'] / merged_df['market_value'] #de
bt to equity ratio
merged_df['EPS'] = merged_df['ni']/merged_df['csho'] #earnings per share
```

For the ratios check for missing values, outliers and data errors. We should also consider winsorizing or log transforming when applicable

In [264]:
```
# check missing values
merged_df.isna().sum()
```

Out[264]:
```
Ticker              0
Name                0
RetYTD              0
gvkey               0
datadate            0
fyear               0
indfmt              0
consol              0
popsrc              0
datafmt             0
curcd               0
assets              0
ceq                 0
csho                0
ebit                0
lt                  0
ni                  0
sale                0
costat              0
prcc_c              0
market_value        0
P/E_ratio           0
P/S_ratio           0
P/B_ratio           0
P/EBIT_ratio        0
E/P_ratio           0
S/P_ratio           0
B/P_ratio           0
EBIT/P_ratio        0
net_profit_margin   0
debt_ratio          0
roa                 0
roe                 0
D/E_ratio           0
EPS                 0
dtype: int64
```

In [265]:
```
# check outliers and distribution of columns
merged_df.describe()
```

Out[265]:

	RetYTD	gvkey	datadate	fyear	assets	ceq	
count	1886.000000	1886.000000	1.886000e+03	1886.000000	1.886000e+03	1886.000000	18
mean	-0.063484	62189.838282	2.021110e+07	2020.911983	2.622079e+04	5024.835206	2
std	0.243801	67853.146760	2.954896e+02	0.283395	1.493189e+05	16277.563302	6
min	-0.787400	1004.000000	2.021013e+07	2020.000000	2.689900e+01	-14999.000000	
25%	-0.199450	11641.250000	2.021123e+07	2021.000000	1.291068e+03	416.276000	
50%	-0.086750	25281.000000	2.021123e+07	2021.000000	4.124783e+03	1109.486000	
75%	0.038750	125591.250000	2.021123e+07	2021.000000	1.307137e+04	3316.116500	1
max	1.735700	317264.000000	2.021123e+07	2021.000000	3.743567e+06	259289.000000	164

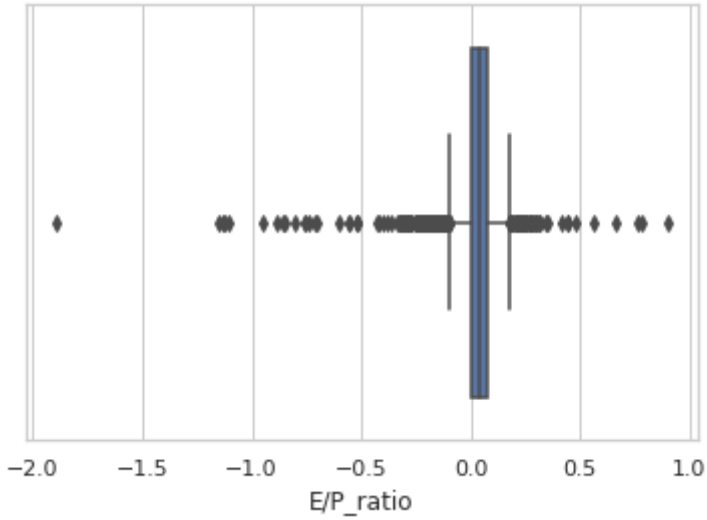
8 rows × 27 columns

In [266]:
```
# let's loop over to check outliers and skewness of ratio columns
cols = ['E/P_ratio', 'S/P_ratio','B/P_ratio', 'EBIT/P_ratio', 'net_profi
t_margin'
       , 'debt_ratio','roa', 'roe', 'D/E_ratio', 'EPS']

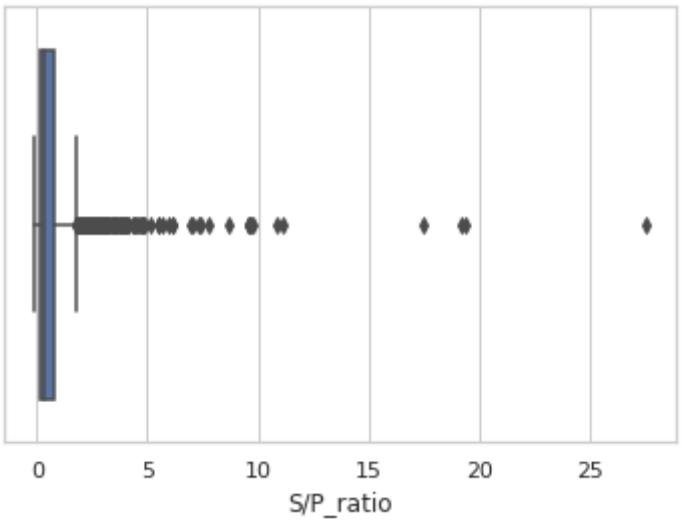


for col in cols:
    print(merged_df[col].describe())
    sns.boxplot(x=merged_df[col])
    plt.show();
```

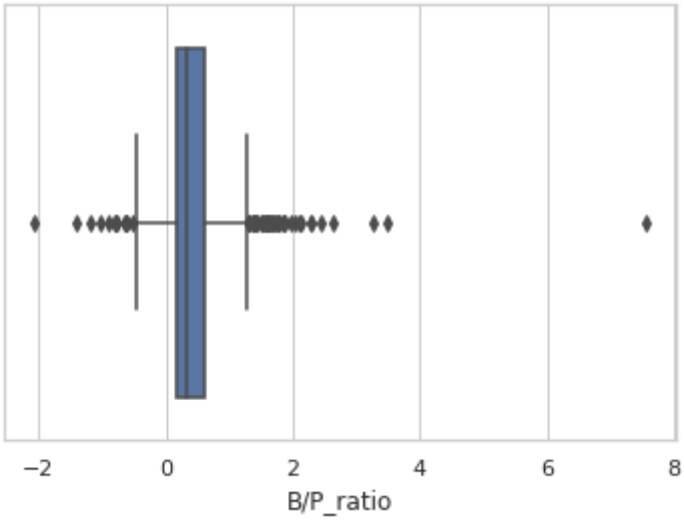
```
count    1886.000000
mean        0.027009
std         0.136353
min        -1.891725
25%         0.008113
50%         0.036704
75%         0.076322
max         0.898517
Name: E/P_ratio, dtype: float64
```



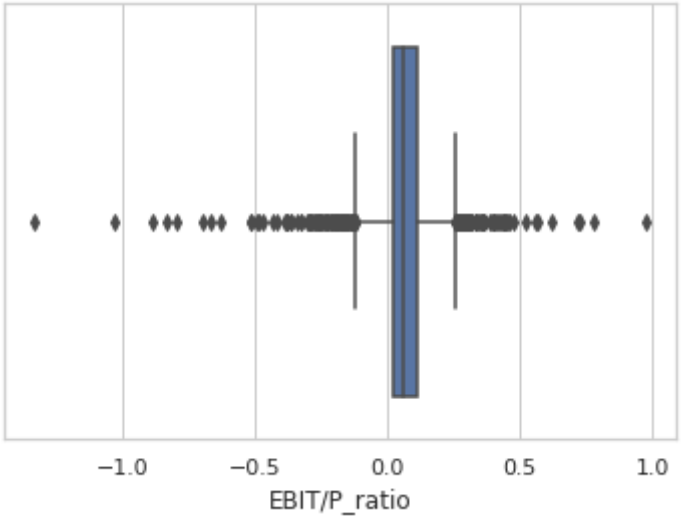

```
count    1886.000000
mean        0.765997
std         1.439881
min        -0.087004
25%         0.176223
50%         0.350729
75%         0.814565
max        27.543662
Name: S/P_ratio, dtype: float64
```



```
count    1886.000000
mean        0.422120
std         0.424100
min        -2.056645
25%         0.161112
50%         0.337004
75%         0.613868
max         7.547555
Name: B/P_ratio, dtype: float64
```

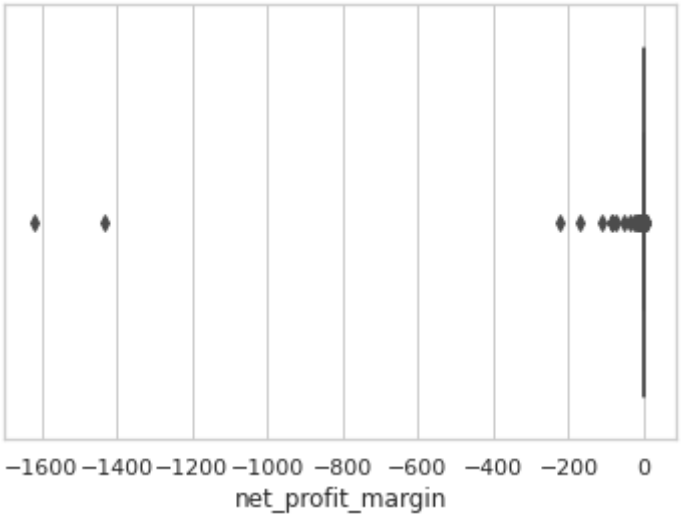



```
count    1886.000000
mean        0.060538
std         0.130324
min        -1.334204
25%         0.019641
50%         0.056821
75%         0.113822
max         0.974888
Name: EBIT/P_ratio, dtype: float64
```

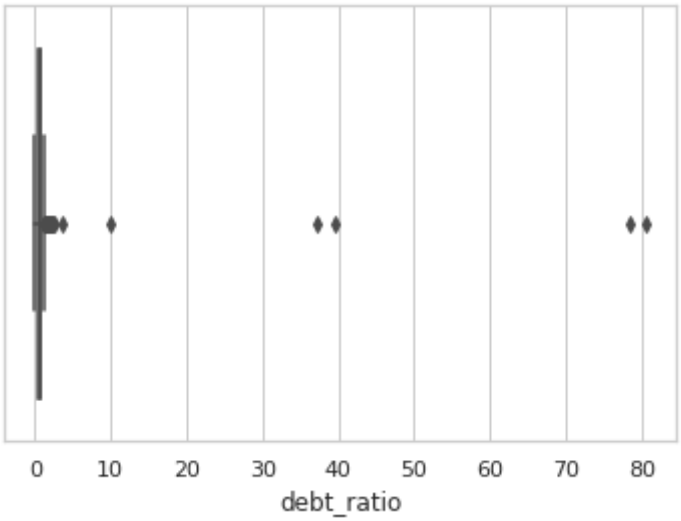


```
count    1886.000000
mean             NaN
std              NaN
min             -inf
25%         0.015657
50%         0.090344
75%         0.199075
max              inf
Name: net_profit_margin, dtype: float64
```

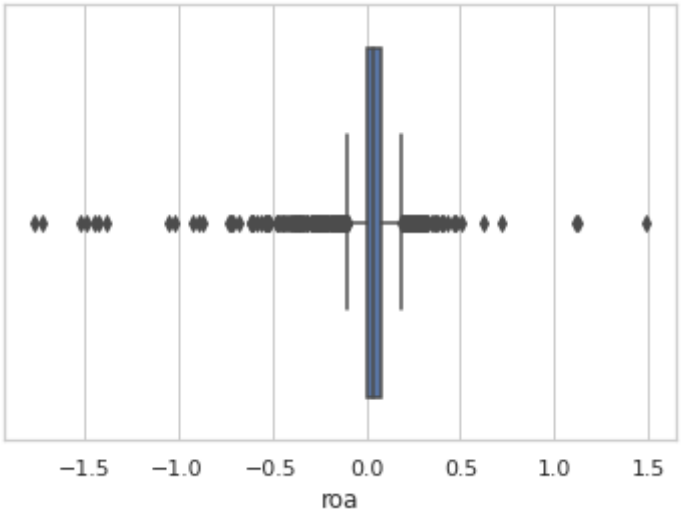
```
/usr/local/lib/python3.7/dist-packages/numpy/core/_methods.py:179: Runt
imeWarning: invalid value encountered in reduce
  ret = umr_sum(arr, axis, dtype, out, keepdims, where=where)
```



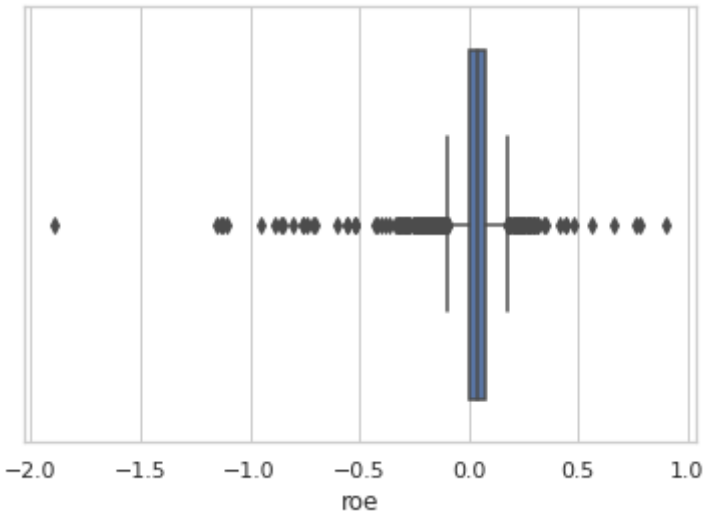

```
count    1886.000000
mean        0.760677
std         2.864605
min         0.008474
25%         0.460233
50%         0.633081
75%         0.802777
max        80.482129
Name: debt_ratio, dtype: float64
```



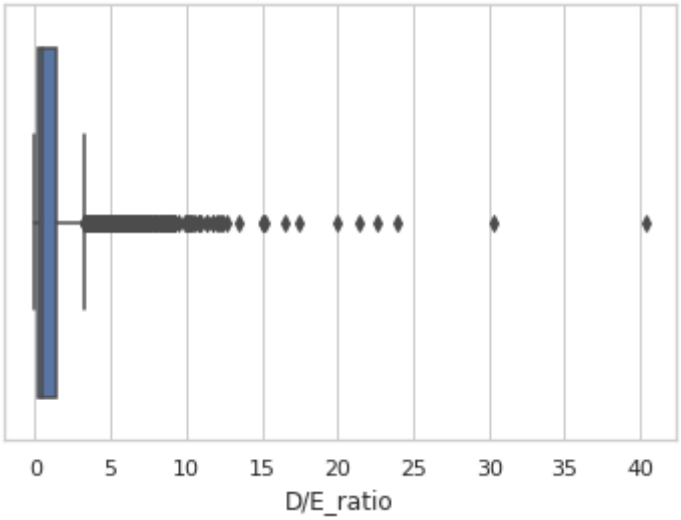
```
count    1886.000000
mean        0.023572
std         0.171422
min        -1.759213
25%         0.007584
50%         0.034187
75%         0.079409
max         1.484070
Name: roa, dtype: float64
```



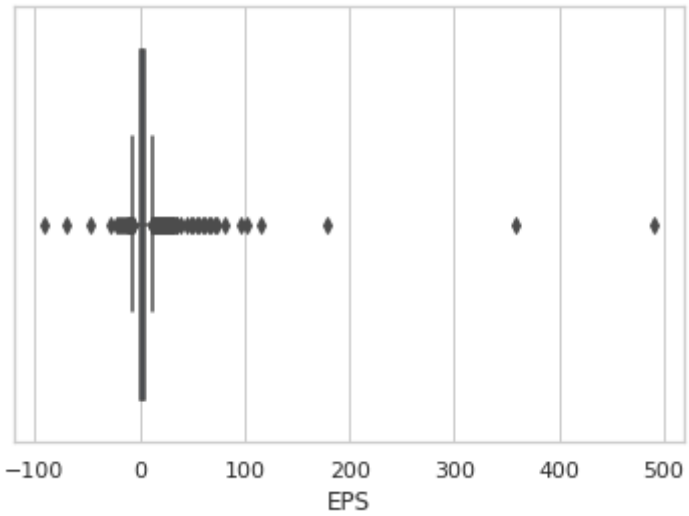

```
count    1886.000000
mean        0.027009
std         0.136353
min        -1.891725
25%         0.008113
50%         0.036704
75%         0.076322
max         0.898517
Name: roe, dtype: float64
```



```
count    1886.000000
mean        1.561028
std         2.764246
min         0.005926
25%         0.217034
50%         0.534134
75%         1.427702
max        40.343655
Name: D/E_ratio, dtype: float64
```




```
count    1886.000000
mean        4.408250
std        16.994272
min       -91.318754
25%         0.287445
50%         2.407403
75%         5.229402
max       490.956072
Name: EPS, dtype: float64
```



Let's winsorize the data as there are several outliers

In [267]:
```
# winsorize outliers based on boxplot distributions

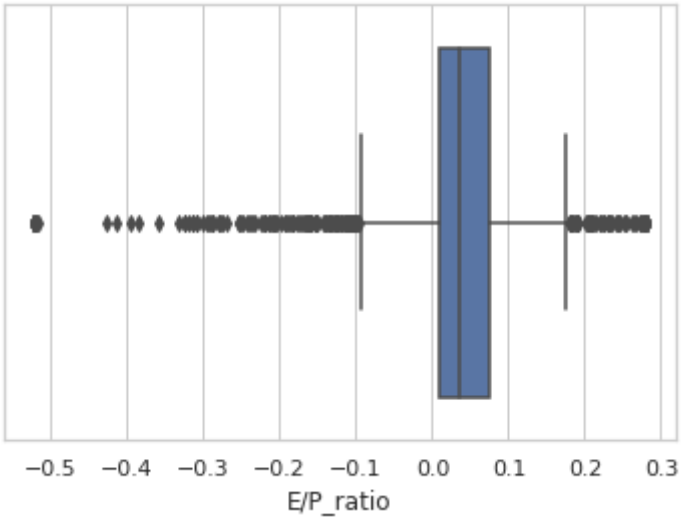
for col in cols:
  merged_df[col] = winsorize(merged_df[col], (0.01,0.01))
```

In [268]:
```
# let's loop over to check outliers and skewness of ratio columns
cols = ['E/P_ratio', 'S/P_ratio','B/P_ratio', 'EBIT/P_ratio', 'net_profi
t_margin',
        'debt_ratio','roa', 'roe', 'D/E_ratio', 'EPS']

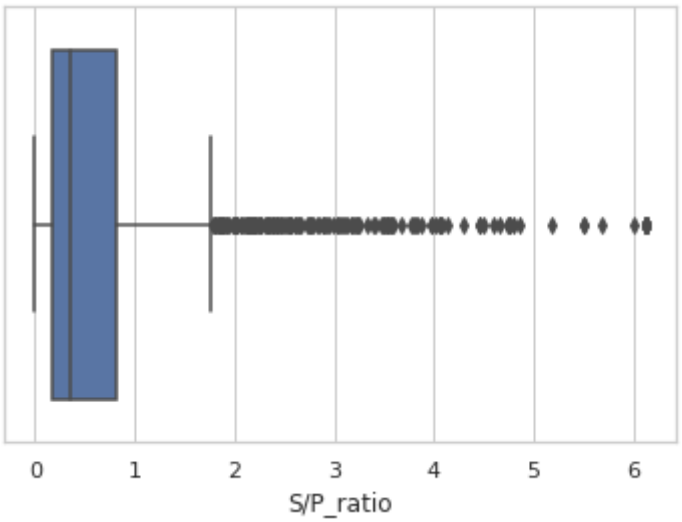


for col in cols:
    print(merged_df[col].describe())
    sns.boxplot(x=merged_df[col])
    plt.show();
```

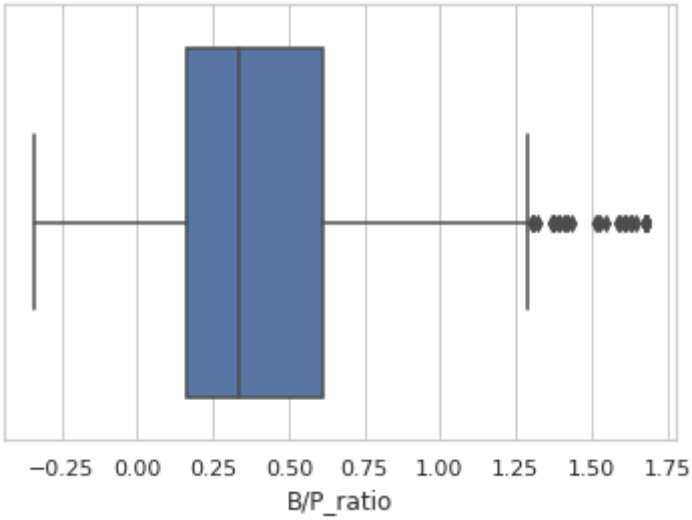
```
count    1886.000000
mean        0.028873
std         0.104512
min        -0.521213
25%         0.008113
50%         0.036704
75%         0.076322
max         0.279700
Name: E/P_ratio, dtype: float64
```



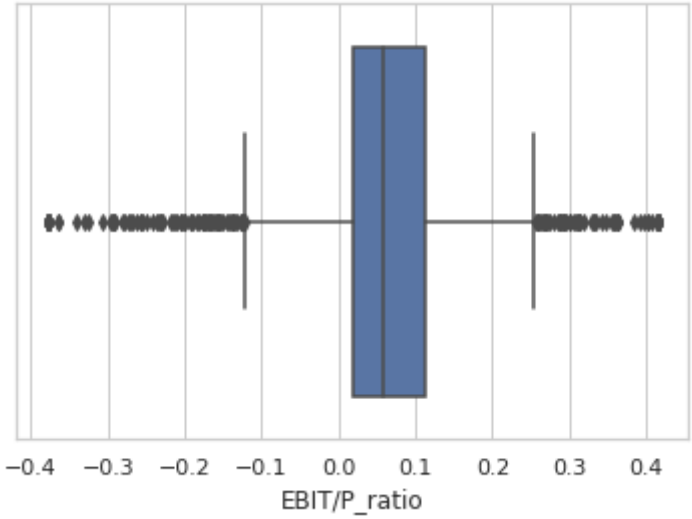

```
count    1886.000000
mean        0.715725
std         0.984952
min         0.000060
25%         0.176223
50%         0.350729
75%         0.814565
max         6.119348
Name: S/P_ratio, dtype: float64
```



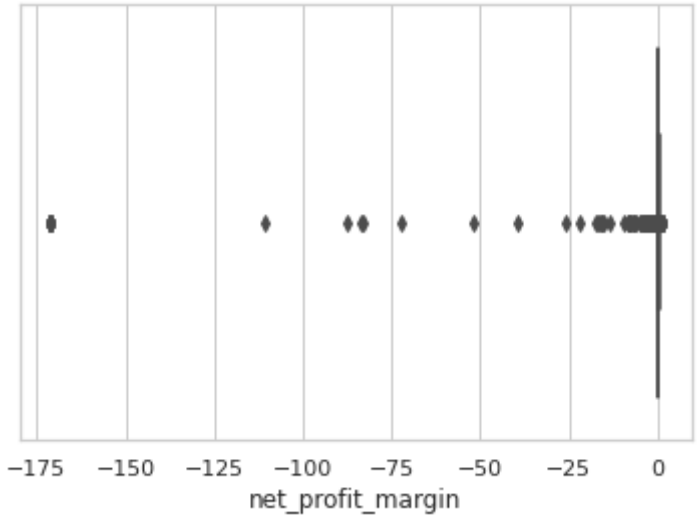
```
count    1886.000000
mean        0.418517
std         0.357616
min        -0.337273
25%         0.161112
50%         0.337004
75%         0.613868
max         1.677414
Name: B/P_ratio, dtype: float64
```



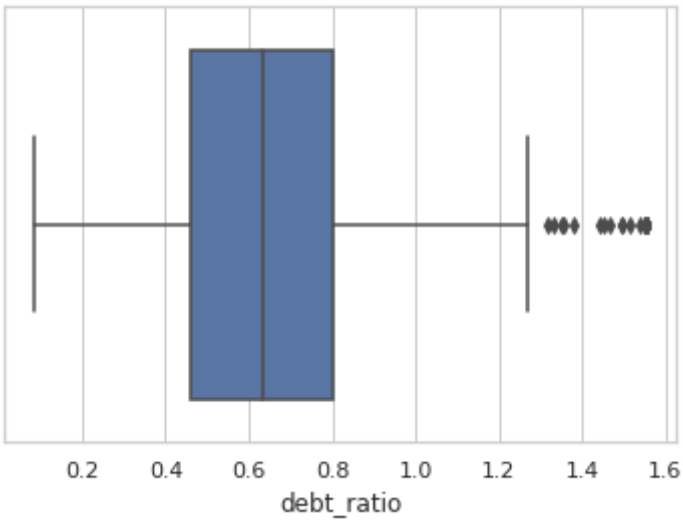

```
count    1886.000000
mean        0.061672
std         0.110981
min        -0.378436
25%         0.019641
50%         0.056821
75%         0.113822
max         0.415467
Name: EBIT/P_ratio, dtype: float64
```



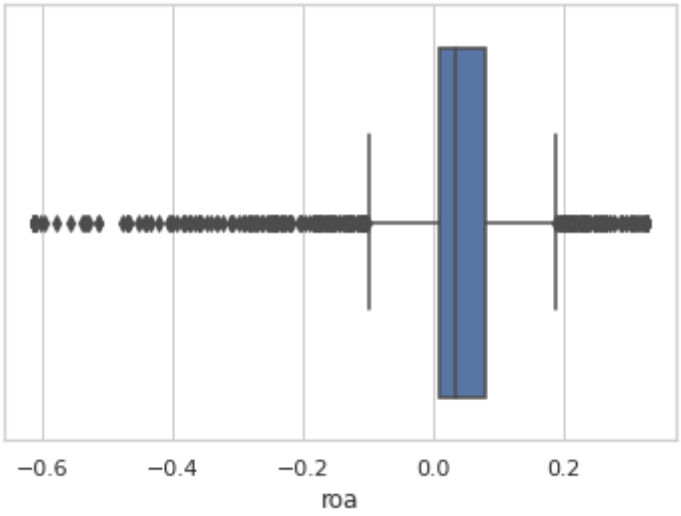
```
count    1886.000000
mean       -2.083802
std        17.769465
min      -171.075493
25%         0.015657
50%         0.090344
75%         0.199075
max         0.908416
Name: net_profit_margin, dtype: float64
```



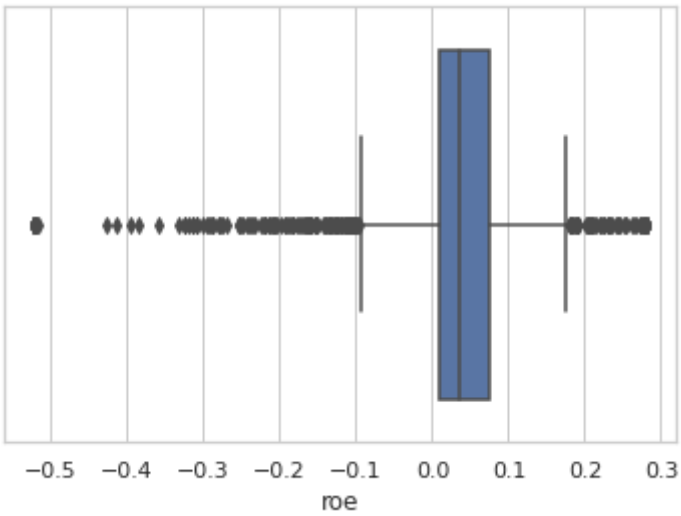

```
count    1886.000000
mean        0.631315
std         0.256761
min         0.086737
25%         0.460233
50%         0.633081
75%         0.802777
max         1.552428
Name: debt_ratio, dtype: float64
```



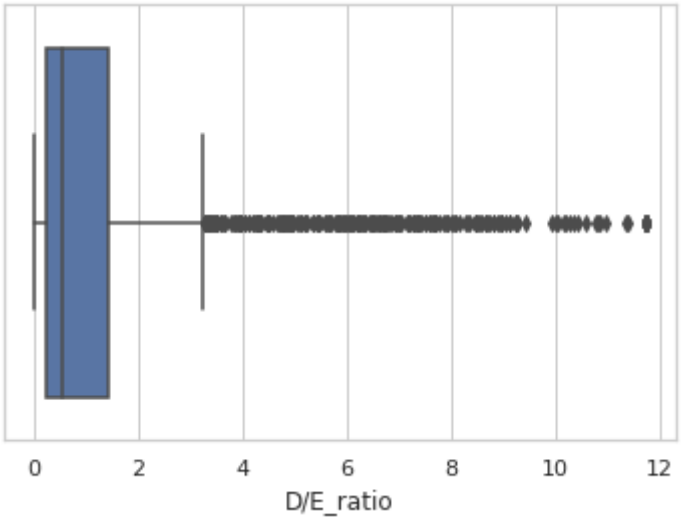
```
count    1886.000000
mean        0.025727
std         0.130224
min        -0.612289
25%         0.007584
50%         0.034187
75%         0.079409
max         0.325773
Name: roa, dtype: float64
```



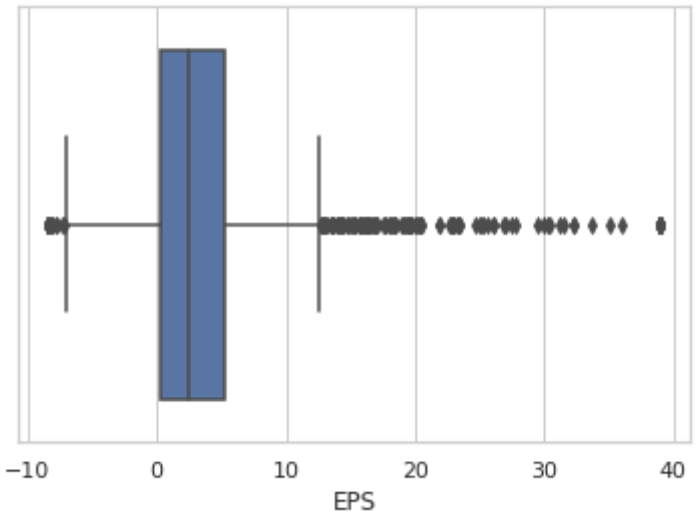

```
count    1886.000000
mean        0.028873
std         0.104512
min        -0.521213
25%         0.008113
50%         0.036704
75%         0.076322
max         0.279700
Name: roe, dtype: float64
```



```
count    1886.000000
mean        1.500729
std         2.347901
min         0.018731
25%         0.217034
50%         0.534134
75%         1.427702
max        11.715856
Name: D/E_ratio, dtype: float64
```




```
count    1886.000000
mean        3.823805
std         6.585012
min        -8.363556
25%         0.287445
50%         2.407403
75%         5.229402
max        38.903246
Name: EPS, dtype: float64
```



Save the final data for the ratios variables

In [269]:
```
final_df = merged_df[['Ticker', 'E/P_ratio', 'S/P_ratio','B/P_ratio', 'EBIT/P_ratio', 'net_profit_margin',
                      'debt_ratio','roa', 'roe', 'D/E_ratio', 'EPS','RetYTD']]
```

In [270]:
```
final_df.head()
```

Out[270]:

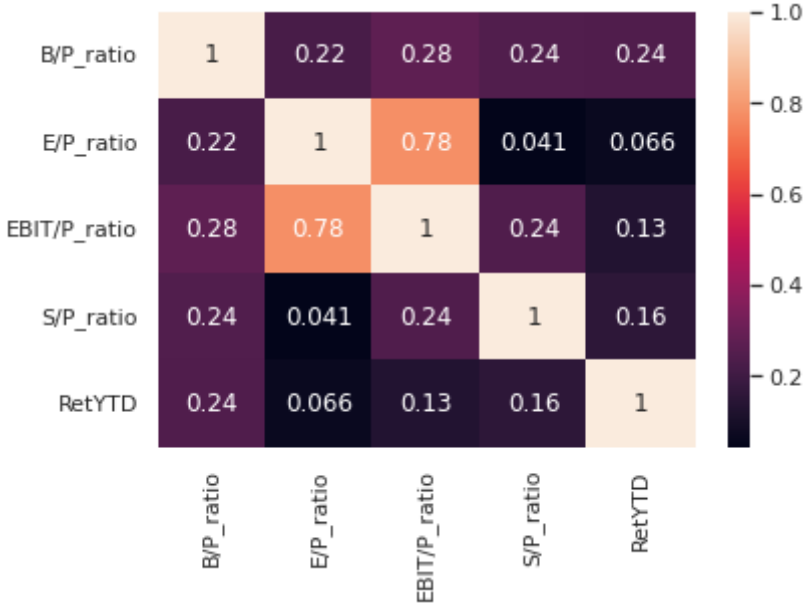
	Ticker	E/P_ratio	S/P_ratio	B/P_ratio	EBIT/P_ratio	net_profit_margin	debt_ratio	roa
0	A	0.025079	0.130970	0.111695	0.029204	0.191486	0.496590	0.113031
1	AA	0.039111	1.107882	0.425940	0.189357	0.035303	0.581764	0.028552
2	AAL	-0.171320	2.568684	-0.337273	-0.378436	-0.066696	1.110431	-0.029985
3	AAN	0.143967	2.416822	0.940491	0.206699	0.059569	0.501711	0.076276
4	AAON	0.014083	0.128111	0.111730	0.017648	0.109927	0.283014	0.090372

In [271]:
```
ratios_df = final_df.drop('RetYTD', axis = 1)
ratios_df.to_csv("Fin-Ratios.csv")
```

Graphs

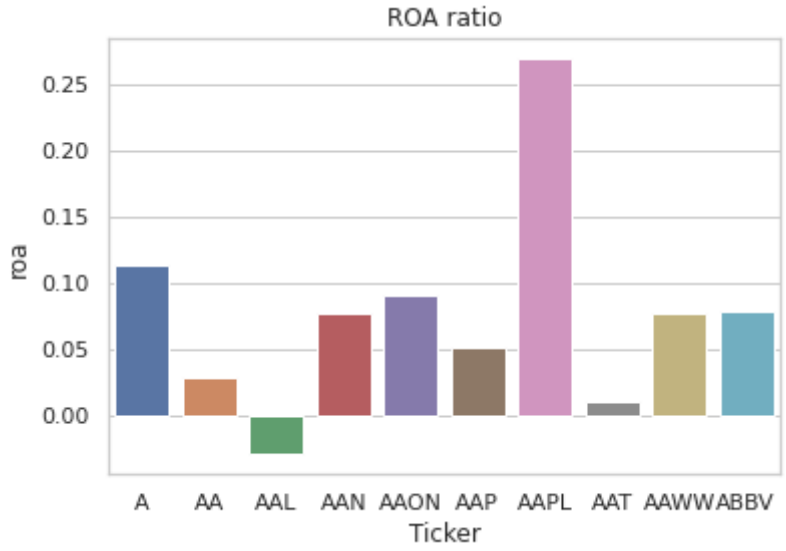
In [272]:
```
corr_features=list(['B/P_ratio', 'E/P_ratio', 'EBIT/P_ratio', 'S/P_ratio', 'RetYTD'])

sns.heatmap(final_df[corr_features].corr(), annot=True);
```

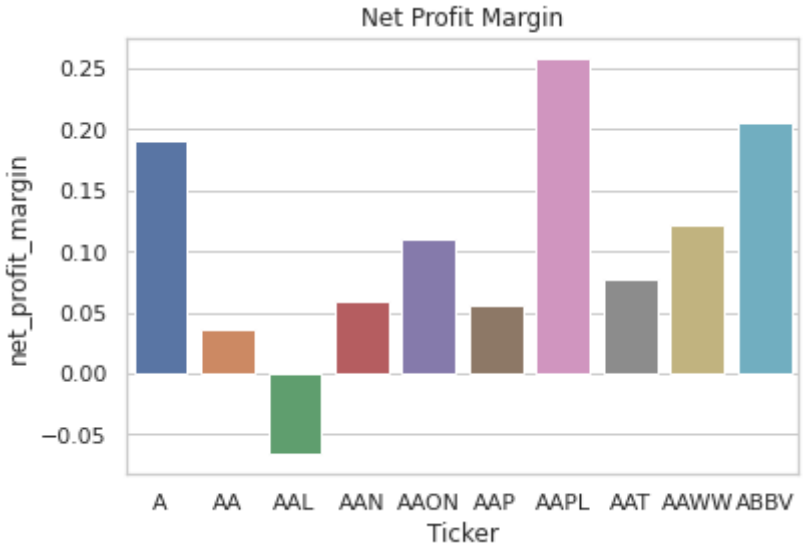


In [273]:
```
# final_df

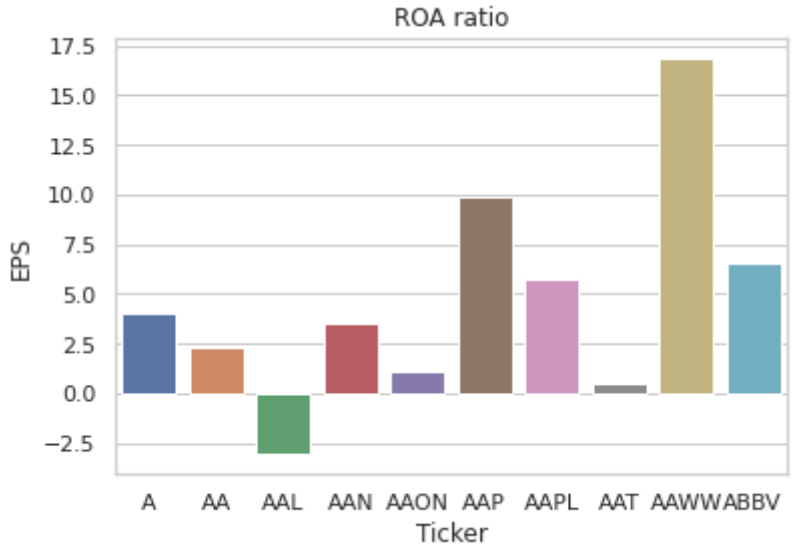
fr_graph = final_df.head(10)
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="Ticker", y="roa", data=fr_graph).set(title='ROA rati
o')
```



In [274]:
```
# fr_graph = final_df.head(10)
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="Ticker", y="net_profit_margin", data=fr_graph).set(t
itle='Net Profit Margin')
```



In [275]:
```
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="Ticker", y="EPS", data=fr_graph).set(title='ROA rati
o')
```



Step 4: Industry Indicators

Merge datasets

In [276]:
```
df_ii = pd.merge(data_pt, data_a5, on='Ticker', how='left')
```

In [277]:
```
# examine merged dataset
df_ii.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 13 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Ticker     1886 non-null   object
 1   Name       1886 non-null   object
 2   RetYTD     1886 non-null   float64
 3   gvkey      1886 non-null   int64
 4   datadate   1886 non-null   int64
 5   fyear      1886 non-null   int64
 6   indfmt     1886 non-null   object
 7   consol     1886 non-null   object
 8   popsrc     1886 non-null   object
 9   datafmt    1886 non-null   object
 10  curcd      1886 non-null   object
 11  costat     1886 non-null   object
 12  ggroup     1886 non-null   int64
dtypes: float64(1), int64(4), object(8)
memory usage: 206.3+ KB
```

In [278]:
```
# check for duplicates
df_ii.duplicated()
```

Out[278]:
```
0       False
1       False
2       False
3       False
4       False
        ...
1881    False
1882    False
1883    False
1884    False
1885    False
Length: 1886, dtype: bool
```

In [279]:
```
df_ii.drop(["Name ","gvkey", "datadate", "fyear", "indfmt", "consol", "p
opsrc", "datafmt",      "curcd", "costat"], axis=1, inplace=True)
```

In [280]:
```
df_ii.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   Ticker  1886 non-null   object 
 1   RetYTD  1886 non-null   float64
 2   ggroup  1886 non-null   int64  
dtypes: float64(1), int64(1), object(1)
memory usage: 58.9+ KB
```

In [281]:
```
df_ii.isna().sum()
```

Out[281]:
```
Ticker    0
RetYTD    0
ggroup    0
dtype: int64
```

In [282]:
```
df_ii['ggroup'].nunique()
```

Out[282]:
```
24
```

In [283]:
```
df_ii['ggroup'].value_counts()
```

Out[283]:
```
2010    183
4010    179
3520    163
6010    131
3510    121
4510    118
1510     95
4020     92
2550     86
4520     82
1010     75
2530     64
2020     63
2520     63
4030     61
5510     58
4530     55
3020     44
5020     42
2030     39
2510     25
3010     17
3030     17
5010     13
Name: ggroup, dtype: int64
```

In [284]:
```
df_ii.head()
```

Out[284]:

	Ticker	RetYTD	ggroup
0	A	-0.2080	3520
1	AA	0.4731	1510
2	AAL	0.0579	2030
3	AAN	-0.1327	2550
4	AAON	-0.3456	2010

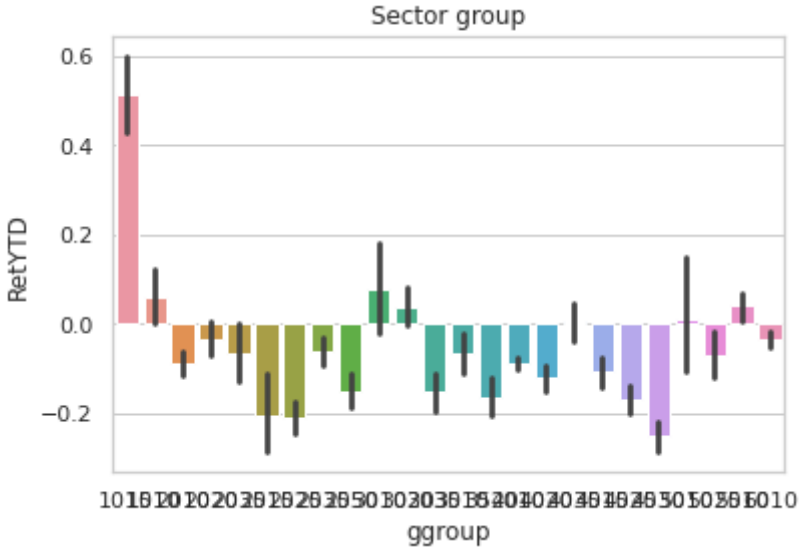
In [285]:
```
df_ii.sort_values(by='ggroup')
```

Out[285]:

	Ticker	RetYTD	ggroup
830	HP	1.0620	1010
907	INT	0.0023	1010
906	INSW	0.4080	1010
1553	SLB	0.4441	1010
1142	MPC	0.3627	1010
...	...	...	...
1278	OFC	0.0072	6010
500	DEI	-0.0743	6010
1462	RHP	0.0332	6010
700	FR	-0.0698	6010
465	CTT	-0.0344	6010

1886 rows × 3 columns

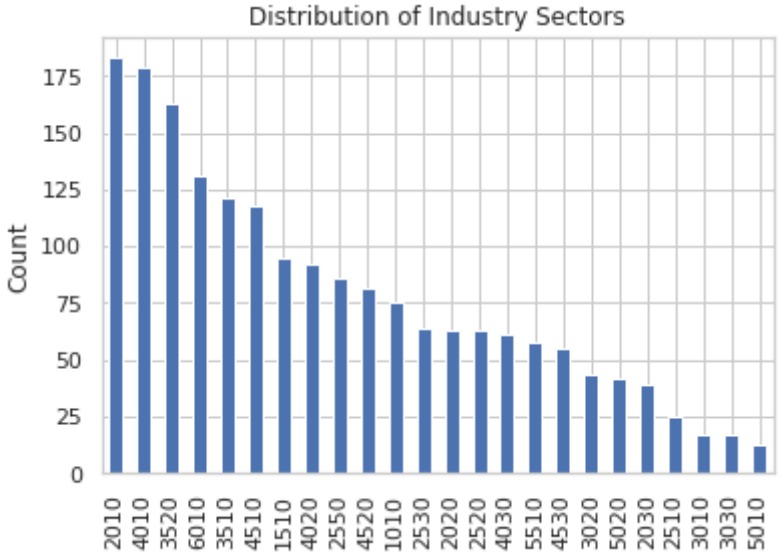
In [286]:
```
fr_graph = final_df.head(10)
sns.set_theme(style="whitegrid")
ax = sns.barplot(x="ggroup", y="RetYTD", data=df_ii).set(title='Sector group')
```



In [287]:
```
df_ii.groupby(['ggroup']).RetYTD.mean().sort_values(ascending=False)
```

Out[287]:
```
ggroup
1010     0.515035
3010     0.078312
1510     0.057846
5510     0.040759
3020     0.038780
5010     0.011838
4030     0.003779
2020    -0.035157
6010    -0.035826
2530    -0.062583
3510    -0.066432
2030    -0.067454
5020    -0.070871
4010    -0.087832
2010    -0.090548
4510    -0.108644
4020    -0.122515
2550    -0.151223
3030    -0.153771
3520    -0.163937
4520    -0.172065
2510    -0.207992
2520    -0.208598
4530    -0.252813
Name: RetYTD, dtype: float64
```

In [288]:
```
# looking at the distribution of the sectors
# create the bar plot
ax = df_ii['ggroup'].value_counts().plot(kind='bar')
# rotate xtick labels
# ax.set_xticklabels(ax.get_xticklabels(), rotation=0)
# set the y-axis label
ax.set_ylabel("Count")
# set the title
ax.set_title("Distribution of Industry Sectors");
```



Create Industry Indicators

In [289]:
```
df_ind = pd.get_dummies(df_ii, columns=['ggroup'])
df_ind
```

Out[289]:

	Ticker	RetYTD	ggroup_1010	ggroup_1510	ggroup_2010	ggroup_2020	ggroup_2030	ggro
0	A	-0.2080	0	0	0	0	0	
1	AA	0.4731	0	1	0	0	0	
2	AAL	0.0579	0	0	0	0	1	
3	AAN	-0.1327	0	0	0	0	0	
4	AAON	-0.3456	0	0	1	0	0	
...	...	...	...	...	...	...	...	
1881	ZEN	0.2002	0	0	0	0	0	
1882	ZION	-0.0038	0	0	0	0	0	
1883	ZNGA	0.3969	0	0	0	0	0	
1884	ZTS	-0.2325	0	0	0	0	0	
1885	ZUMZ	-0.1792	0	0	0	0	0	

1886 rows × 26 columns

In [290]:
```
df_ind.to_csv("Industry.csv", index=False)
```

Step 5: Run OLS explanatory for 4 categories:

a. Risk Regressions:

- i. Ret(i) = a + b1*MktExposure(i)* + *b2*SizeExposure(i) + b3*ValueExposure(i) + e

In [291]:
```
# merge datasets df_ff & data_pt on Ticker

df_ff.rename(columns={'TICKER':'Ticker'}, inplace=True)

risk_reg = pd.merge(data_pt, df_ff, on='Ticker', how='left')
risk_reg.head(10)
```

Out[291]:

	Ticker	Name	RetYTD	mktrf	smb	hml
0	A	Agilent Technologies	-0.2080	1.014152	-0.253674	-0.143608
1	AA	Alcoa Corp	0.4731	1.984149	0.527862	1.924844
2	AAL	American Airlines Gp	0.0579	1.315550	0.612825	1.248123
3	AAN	Aarons Holdings Company	-0.1327	1.063239	0.668200	0.315612
4	AAON	Aaon Inc	-0.3456	0.516779	0.422130	-0.117068
5	AAP	Advance Auto Parts Inc	-0.0884	1.112646	0.123161	0.469651
6	AAPL	Apple Inc	-0.0692	1.314647	-0.344850	-0.714986
7	AAT	American Assets Trust	-0.0384	1.007945	0.384752	0.685424
8	AAWW	Atlas Air Ww	-0.2727	0.971779	0.591275	0.283819
9	ABBV	Abbvie Inc	0.1987	0.774071	0.083434	0.204134

In [292]:
```
# only keep columns we need for regression
risk_reg = risk_reg.drop(columns=['Ticker', 'Name '])
#let's look at the updated data
risk_reg.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   RetYTD  1886 non-null   float64
 1   mktrf   1886 non-null   float64
 2   smb     1886 non-null   float64
 3   hml     1886 non-null   float64
dtypes: float64(4)
memory usage: 73.7 KB
```

In [293]:
```
# select the independent variables for mkt, size and value
X1 = risk_reg[['mktrf', 'smb', 'hml']]
y1 = risk_reg['RetYTD']

# add constant column
X1 = sm.add_constant(X1)
model = sm.OLS(y1, X1).fit()

model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/tsatools.py:117:
FutureWarning: In a future version of pandas all arguments of concat ex
cept for the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
```

Out[293]:

OLS Regression Results

Dep. Variable:	RetYTD	**R-squared:**	0.095
Model:	OLS	**Adj. R-squared:**	0.094
Method:	Least Squares	**F-statistic:**	65.99
Date:	Thu, 28 Apr 2022	**Prob (F-statistic):**	1.43e-40
Time:	01:50:26	**Log-Likelihood:**	80.608
No. Observations:	1886	**AIC:**	-153.2
Df Residuals:	1882	**BIC:**	-131.0
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.0982	0.011	-8.778	0.000	-0.120	-0.076
mktrf	0.0084	0.009	0.976	0.329	-0.009	0.025
smb	-0.0121	0.004	-2.770	0.006	-0.021	-0.004
hml	0.1073	0.008	13.866	0.000	0.092	0.122

Omnibus:	641.661	**Durbin-Watson:**	2.004
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	3596.936
Skew:	1.491	**Prob(JB):**	0.00
Kurtosis:	9.073	**Cond. No.**	4.57

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

ii. Interpret and explain your findings (focus on R2, Adj R2 and coefficients)

- As we see from the regression above, R2 is 0.095. More specifically, R-squared gives you the percentage variation in y explained by x-variables. Given R-squared and Adjusted R-squared from this regression, 9.5% of the stocks' return explained by market, size and value risk factors
- Constant
  - The constant has a value of -0.0982. The constant is alpha in this case P-value is less than 0.05 and t-stat is more than 1.95 meaning that it is statistically significant and we are confident that the value is not 0. Over the early months of 2022, beyond what happened with the stock market(mktrf), and the other two risk factors, the stock portfolio went down by 9.8% on average.
- mkrtf
  - The mktrf has a value of 0.0084. This is the coefficient of the market risk. P-value is more than 0.05 and t-stat's absolute value is less than 1.95 so it is not statistically significant. The value of the coefficient tells us that the average value of the stock portfolio is less volatile than the market since it is less than 1. Since the 95% confidence interval does not include 1, we can reject the assertion that the value includes 1.
- smb
  - The smb has a value of -0.0121. This is the coefficient of the size risk. P-value is less than 0.05 and t-stat is more than 1.95 meaning that it is statistically significant and we are confident that the value is not 0. The sign of the coefficient tells us that the portfolio of stocks looks more like large stocks. This finding makes sense since the Russell 3000 Index is a market-capitalization-weighted equity index that seeks to track 3000 of the largest U.S.-traded stocks. Since the 95% confidence interval does not include 1, we can reject the assertion that the value includes 0.
- hml
  - The hml has a value of 0.1073. This is the coefficient of the value risk. P-value is less than 0.05 and t-stat is more than 1.95 meaning that it is statistically significant and we are confident that the value is not 0. The sign of the coefficient tells us that the portfolio of stocks looks more like value stocks. Since the 95% confidence interval does not include 1, we can reject the assertion that the value includes 0.

b. Financial Characteristics:

i. Ret(i) = a + c1*Ratio1(i)* + *c2*Ratio2(i) + … + c10*Ratio10 (i) + e

In [294]:
```
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   Ticker             1886 non-null   object 
 1   E/P_ratio          1886 non-null   float64
 2   S/P_ratio          1886 non-null   float64
 3   B/P_ratio          1886 non-null   float64
 4   EBIT/P_ratio       1886 non-null   float64
 5   net_profit_margin  1886 non-null   float64
 6   debt_ratio         1886 non-null   float64
 7   roa                1886 non-null   float64
 8   roe                1886 non-null   float64
 9   D/E_ratio          1886 non-null   float64
 10  EPS                1886 non-null   float64
 11  RetYTD             1886 non-null   float64
dtypes: float64(11), object(1)
memory usage: 191.5+ KB
```

In [295]:
```
# select the independent variables for ratios

X2 = final_df.drop(columns=['RetYTD', 'Ticker'])
y2 = final_df['RetYTD']

# add constant column
X2 = sm.add_constant(X2)
model = sm.OLS(y2, X2).fit()

model.summary()
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tsa/tsatools.py:117:
FutureWarning: In a future version of pandas all arguments of concat ex
cept for the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
```

Out[295]:

OLS Regression Results

Dep. Variable:	RetYTD	**R-squared:**	0.111
Model:	OLS	**Adj. R-squared:**	0.107
Method:	Least Squares	**F-statistic:**	26.14
Date:	Thu, 28 Apr 2022	**Prob (F-statistic):**	7.90e-43
Time:	01:50:26	**Log-Likelihood:**	97.678
No. Observations:	1886	**AIC:**	-175.4
Df Residuals:	1876	**BIC:**	-119.9
Df Model:	9		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-0.2596	0.020	-12.907	0.000	-0.299	-0.220
E/P_ratio	-0.2016	0.052	-3.871	0.000	-0.304	-0.099
S/P_ratio	0.0103	0.006	1.726	0.085	-0.001	0.022
B/P_ratio	0.2477	0.021	11.953	0.000	0.207	0.288
EBIT/P_ratio	0.3173	0.087	3.643	0.000	0.146	0.488
net_profit_margin	-0.0007	0.000	-1.975	0.048	-0.001	-4.63e-06
debt_ratio	0.1767	0.028	6.321	0.000	0.122	0.231
roa	0.3422	0.064	5.349	0.000	0.217	0.468
roe	-0.2016	0.052	-3.871	0.000	-0.304	-0.099
D/E_ratio	-0.0231	0.004	-6.514	0.000	-0.030	-0.016
EPS	-0.0026	0.001	-2.706	0.007	-0.004	-0.001

Omnibus:	648.100	**Durbin-Watson:**	2.018
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	4020.436
Skew:	1.473	**Prob(JB):**	0.00
Kurtosis:	9.518	**Cond. No.**	4.33e+17

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 3.21e-30. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

ii. Interpret and explain your findings (focus on R2, Adj R2 and coefficients)

R-squared and Adjusted R-squared tells us that around 10% of the variance in the stocks' return is explained by the financial ratios used as independent variables. The ratios are better at explaining the variance in stock returns (Adj R2~10%) compared to the fama french variables.

- All of the ratios, except for S/P ratio, have p-values less than 0.05 and t-stat absolute values of more than 1.95, meaning that they are statistically significant.
- Notable coefficients
  - ROA (Return on Assets) has the highest positive coefficient value at 0.3422. This means that when ROA increases by 1, the return on the stock portfolio is expected to increase by 0.3422.
  - EBIT/P_ratio (EBIT to Price ratio) has the second highest positive coefficient value at 0.3173. This means that when EBIT-to-Price ratio increases by 1, the return on the stock portfolio is expected to increase by 0.3173.
  - B/P_ratio (Book to Price ratio) has the third highest positive coefficient value at 0.2477. This means that when Book to Price ratio increases by 1, the return on the stock portfolio is expected to increase by 0.2477.

c. Industry Dummies:

i. Ret(i) = a + coefficients*IndustryDummies + e

In [296]:
```
# only keep independent variables for industry indicators
X3 = df_ind.drop(columns=['RetYTD', 'Ticker'])

y3 = df_ind['RetYTD']

# add constant
# X3 = sm.add_constant(X3)
model = sm.OLS(y3, X3).fit()

model.summary()
```

Out[296]:

OLS Regression Results

Dep. Variable:	RetYTD	**R-squared:**	0.326
Model:	OLS	**Adj. R-squared:**	0.317
Method:	Least Squares	**F-statistic:**	39.07
Date:	Thu, 28 Apr 2022	**Prob (F-statistic):**	6.29e-141
Time:	01:50:26	**Log-Likelihood:**	357.63
No. Observations:	1886	**AIC:**	-667.3
Df Residuals:	1862	**BIC:**	-534.2
Df Model:	23		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
ggroup_1010	0.5150	0.023	22.140	0.000	0.469	0.561
ggroup_1510	0.0578	0.021	2.799	0.005	0.017	0.098
ggroup_2010	-0.0905	0.015	-6.080	0.000	-0.120	-0.061
ggroup_2020	-0.0352	0.025	-1.385	0.166	-0.085	0.015
ggroup_2030	-0.0675	0.032	-2.091	0.037	-0.131	-0.004
ggroup_2510	-0.2080	0.040	-5.162	0.000	-0.287	-0.129
ggroup_2520	-0.2086	0.025	-8.218	0.000	-0.258	-0.159
ggroup_2530	-0.0626	0.025	-2.485	0.013	-0.112	-0.013
ggroup_2550	-0.1512	0.022	-6.961	0.000	-0.194	-0.109
ggroup_3010	0.0783	0.049	1.603	0.109	-0.018	0.174
ggroup_3020	0.0388	0.030	1.277	0.202	-0.021	0.098
ggroup_3030	-0.1538	0.049	-3.147	0.002	-0.250	-0.058
ggroup_3510	-0.0664	0.018	-3.627	0.000	-0.102	-0.031
ggroup_3520	-0.1639	0.016	-10.389	0.000	-0.195	-0.133
ggroup_4010	-0.0878	0.015	-5.833	0.000	-0.117	-0.058
ggroup_4020	-0.1225	0.021	-5.833	0.000	-0.164	-0.081
ggroup_4030	0.0038	0.026	0.146	0.884	-0.047	0.054
ggroup_4510	-0.1086	0.019	-5.858	0.000	-0.145	-0.072
ggroup_4520	-0.1721	0.022	-7.734	0.000	-0.216	-0.128
ggroup_4530	-0.2528	0.027	-9.307	0.000	-0.306	-0.200
ggroup_5010	0.0118	0.056	0.212	0.832	-0.098	0.121
ggroup_5020	-0.0709	0.031	-2.280	0.023	-0.132	-0.010
ggroup_5510	0.0408	0.026	1.541	0.124	-0.011	0.093
ggroup_6010	-0.0358	0.018	-2.035	0.042	-0.070	-0.001

Omnibus:	403.265	**Durbin-Watson:**	2.038
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	2314.656
Skew:	0.877	**Prob(JB):**	0.00
Kurtosis:	8.136	**Cond. No.**	3.75

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

ii. Interpret and explain your findings (focus on R2, Adj R2 and coefficients)

R-squared and Adjusted R-squared tells us that around 31% of the variance in the stocks' return is explained by the industry indicators used as independent variables. The industry indicators are even better at explaining the variance in stock returns (Adj R2~31%) compared to the fama french variables and the ratios.

- All of the industry indicators (except for ggroup_2020, ggroup_3010, ggroup_3020, ggroup_4030, ggroup_5010, ggroup_5510) have p-values less than 0.05 and t-stat absolute values of more than 1.95, meaning that they are statistically significant.
- Notable coefficients
  - ggroup_1010 (Energy Sector) has the highest positive coefficient value at 0.5150. This means that when ggroup_1010 increases by 1, the return on the stock portfolio is expected to increase by 0.5150.
  - ggroup_4530 (Semiconductors & Semiconductor Equipment Sector) has a negative coefficient value at -0.2528. This means that when ggroup_4530 increases by 1, the return on the stock portfolio is expected to decrease by 0.2528.
  - ggroup_2520 (Consumer Durables & Apparel Sector) has a negative coefficient value at -0.2086. This means that when ggroup_2520 increases by 1, the return on the stock portfolio is expected to decrease by 0.2086.
  - ggroup_2510 (Automobiles & Components Sector) has a negative coefficient value at -0.2080. This means that when ggroup_2510 increases by 1, the return on the stock portfolio is expected to decrease by 0.2080.

d. Combined Regressions:

i. Combine the various regressions in steps (a-c) above.

First let's look at the datasets we have to use: Risk, Financial ratios and Industry indicator

In [297]:
```
df_ff.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   Ticker  1886 non-null   object 
 1   mktrf   1886 non-null   float64
 2   smb     1886 non-null   float64
 3   hml     1886 non-null   float64
dtypes: float64(3), object(1)
memory usage: 73.7+ KB
```

In [298]:
```
ratios_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 11 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   Ticker             1886 non-null   object 
 1   E/P_ratio          1886 non-null   float64
 2   S/P_ratio          1886 non-null   float64
 3   B/P_ratio          1886 non-null   float64
 4   EBIT/P_ratio       1886 non-null   float64
 5   net_profit_margin  1886 non-null   float64
 6   debt_ratio         1886 non-null   float64
 7   roa                1886 non-null   float64
 8   roe                1886 non-null   float64
 9   D/E_ratio          1886 non-null   float64
 10  EPS                1886 non-null   float64
dtypes: float64(10), object(1)
memory usage: 176.8+ KB
```

In [299]:
```
df_ind.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 26 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   Ticker       1886 non-null   object
 1   RetYTD       1886 non-null   float64
 2   ggroup_1010  1886 non-null   uint8
 3   ggroup_1510  1886 non-null   uint8
 4   ggroup_2010  1886 non-null   uint8
 5   ggroup_2020  1886 non-null   uint8
 6   ggroup_2030  1886 non-null   uint8
 7   ggroup_2510  1886 non-null   uint8
 8   ggroup_2520  1886 non-null   uint8
 9   ggroup_2530  1886 non-null   uint8
 10  ggroup_2550  1886 non-null   uint8
 11  ggroup_3010  1886 non-null   uint8
 12  ggroup_3020  1886 non-null   uint8
 13  ggroup_3030  1886 non-null   uint8
 14  ggroup_3510  1886 non-null   uint8
 15  ggroup_3520  1886 non-null   uint8
 16  ggroup_4010  1886 non-null   uint8
 17  ggroup_4020  1886 non-null   uint8
 18  ggroup_4030  1886 non-null   uint8
 19  ggroup_4510  1886 non-null   uint8
 20  ggroup_4520  1886 non-null   uint8
 21  ggroup_4530  1886 non-null   uint8
 22  ggroup_5010  1886 non-null   uint8
 23  ggroup_5020  1886 non-null   uint8
 24  ggroup_5510  1886 non-null   uint8
 25  ggroup_6010  1886 non-null   uint8
dtypes: float64(1), object(1), uint8(24)
memory usage: 152.9+ KB
```

Let's combine the datasets into one

In [300]:
```
final_merged_df = pd.merge(df_ff, ratios_df, on = 'Ticker', how = 'left'
)
final_merged_df = pd.merge(final_merged_df, df_ind, on = 'Ticker', how =
'left')
```

In [301]:
```
final_merged_df.head()
```

Out[301]:

	Ticker	mktrf	smb	hml	E/P_ratio	S/P_ratio	B/P_ratio	EBIT/P_ratio	net_profit
0	A	1.014152	-0.253674	-0.143608	0.025079	0.130970	0.111695	0.029204	(
1	AA	1.984149	0.527862	1.924844	0.039111	1.107882	0.425940	0.189357	(
2	AAL	1.315550	0.612825	1.248123	-0.171320	2.568684	-0.337273	-0.378436	-(
3	AAN	1.063239	0.668200	0.315612	0.143967	2.416822	0.940491	0.206699	(
4	AAON	0.516779	0.422130	-0.117068	0.014083	0.128111	0.111730	0.017648	(

5 rows × 39 columns

In [302]:
```
final_merged_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1886 entries, 0 to 1885
Data columns (total 39 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   Ticker              1886 non-null   object 
 1   mktrf               1886 non-null   float64
 2   smb                 1886 non-null   float64
 3   hml                 1886 non-null   float64
 4   E/P_ratio           1886 non-null   float64
 5   S/P_ratio           1886 non-null   float64
 6   B/P_ratio           1886 non-null   float64
 7   EBIT/P_ratio        1886 non-null   float64
 8   net_profit_margin   1886 non-null   float64
 9   debt_ratio          1886 non-null   float64
 10  roa                 1886 non-null   float64
 11  roe                 1886 non-null   float64
 12  D/E_ratio           1886 non-null   float64
 13  EPS                 1886 non-null   float64
 14  RetYTD              1886 non-null   float64
 15  ggroup_1010         1886 non-null   uint8  
 16  ggroup_1510         1886 non-null   uint8  
 17  ggroup_2010         1886 non-null   uint8  
 18  ggroup_2020         1886 non-null   uint8  
 19  ggroup_2030         1886 non-null   uint8  
 20  ggroup_2510         1886 non-null   uint8  
 21  ggroup_2520         1886 non-null   uint8  
 22  ggroup_2530         1886 non-null   uint8  
 23  ggroup_2550         1886 non-null   uint8  
 24  ggroup_3010         1886 non-null   uint8  
 25  ggroup_3020         1886 non-null   uint8  
 26  ggroup_3030         1886 non-null   uint8  
 27  ggroup_3510         1886 non-null   uint8  
 28  ggroup_3520         1886 non-null   uint8  
 29  ggroup_4010         1886 non-null   uint8  
 30  ggroup_4020         1886 non-null   uint8  
 31  ggroup_4030         1886 non-null   uint8  
 32  ggroup_4510         1886 non-null   uint8  
 33  ggroup_4520         1886 non-null   uint8  
 34  ggroup_4530         1886 non-null   uint8  
 35  ggroup_5010         1886 non-null   uint8  
 36  ggroup_5020         1886 non-null   uint8  
 37  ggroup_5510         1886 non-null   uint8  
 38  ggroup_6010         1886 non-null   uint8  
dtypes: float64(14), object(1), uint8(24)
memory usage: 280.0+ KB
```

In [303]:
```
# let's drop Ticker so we only keep the columns that are meaningful for
 the regression
final_merged_df.drop('Ticker', axis =1, inplace = True)
```

In [304]:
```
# only keep independent variables for all 3 previous models
X4 = final_merged_df.drop(columns=['RetYTD'])

y4 = final_merged_df['RetYTD']

# add constant
# X3 = sm.add_constant(X3)
model = sm.OLS(y4, X4).fit()

model.summary()
```

Out[304]:

OLS Regression Results

Dep. Variable:	RetYTD	**R-squared:**	0.388
Model:	OLS	**Adj. R-squared:**	0.376
Method:	Least Squares	**F-statistic:**	33.50
Date:	Thu, 28 Apr 2022	**Prob (F-statistic):**	1.29e-169
Time:	01:50:27	**Log-Likelihood:**	449.17
No. Observations:	1886	**AIC:**	-826.3
Df Residuals:	1850	**BIC:**	-626.8
Df Model:	35		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
mktrf	-0.0158	0.008	-1.935	0.053	-0.032	0.000
smb	-0.0172	0.004	-4.039	0.000	-0.026	-0.009
hml	0.0636	0.009	7.306	0.000	0.047	0.081
E/P_ratio	-0.0542	0.045	-1.210	0.226	-0.142	0.034
S/P_ratio	0.0051	0.006	0.807	0.420	-0.007	0.018
B/P_ratio	0.1153	0.020	5.903	0.000	0.077	0.154
EBIT/P_ratio	0.1165	0.076	1.533	0.125	-0.033	0.266
net_profit_margin	-0.0005	0.000	-1.711	0.087	-0.001	7.09e-05
debt_ratio	0.0932	0.026	3.643	0.000	0.043	0.143
roa	0.2172	0.059	3.657	0.000	0.101	0.334
roe	-0.0542	0.045	-1.210	0.226	-0.142	0.034
D/E_ratio	-0.0050	0.004	-1.322	0.186	-0.012	0.002
EPS	-0.0017	0.001	-2.020	0.044	-0.003	-4.92e-05
ggroup_1010	0.3583	0.036	9.939	0.000	0.288	0.429
ggroup_1510	-0.0674	0.029	-2.309	0.021	-0.125	-0.010
ggroup_2010	-0.1918	0.025	-7.584	0.000	-0.241	-0.142
ggroup_2020	-0.1455	0.032	-4.553	0.000	-0.208	-0.083
ggroup_2030	-0.1981	0.038	-5.227	0.000	-0.272	-0.124
ggroup_2510	-0.3296	0.046	-7.211	0.000	-0.419	-0.240
ggroup_2520	-0.3200	0.033	-9.726	0.000	-0.385	-0.256
ggroup_2530	-0.1640	0.035	-4.682	0.000	-0.233	-0.095
ggroup_2550	-0.2589	0.033	-7.828	0.000	-0.324	-0.194
ggroup_3010	-0.0511	0.053	-0.963	0.336	-0.155	0.053
ggroup_3020	-0.0779	0.035	-2.217	0.027	-0.147	-0.009

ggroup_3030	-0.2554	0.051	-4.990	0.000	-0.356	-0.155
ggroup_3510	-0.1078	0.025	-4.276	0.000	-0.157	-0.058
ggroup_3520	-0.1409	0.025	-5.558	0.000	-0.191	-0.091
ggroup_4010	-0.2655	0.033	-8.031	0.000	-0.330	-0.201
ggroup_4020	-0.2577	0.032	-8.064	0.000	-0.320	-0.195
ggroup_4030	-0.1673	0.037	-4.578	0.000	-0.239	-0.096
ggroup_4510	-0.1449	0.027	-5.288	0.000	-0.199	-0.091
ggroup_4520	-0.2558	0.030	-8.606	0.000	-0.314	-0.197
ggroup_4530	-0.2984	0.032	-9.345	0.000	-0.361	-0.236
ggroup_5010	-0.1409	0.058	-2.421	0.016	-0.255	-0.027
ggroup_5020	-0.1527	0.037	-4.178	0.000	-0.224	-0.081
ggroup_5510	-0.0924	0.033	-2.772	0.006	-0.158	-0.027
ggroup_6010	-0.1516	0.027	-5.649	0.000	-0.204	-0.099

Omnibus:	451.573	**Durbin-Watson:**	2.017
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	2719.174
Skew:	0.983	**Prob(JB):**	0.00
Kurtosis:	8.544	**Cond. No.**	1.56e+16

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.49e-27. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

ii. Interpret and explain your findings (focus on R2, Adj R2 and coefficients)

R-squared and Adjusted R-squared tells us that around 37% of the variance in the stocks' return is explained by the fama french metrics, financial ratios and industry indicators, used as independent variables. This combined regression performs even better explaining the variance in stock returns (Adj R2~37%) when adding more variables, when compared to the previous three standalone regressions. When analyzing the other three regressions, we can conclude that industry indicators explained most of the financial returns variance.

Conclusion and recommendation

Conclusion

This project covered financial analysis of stock returns for stocks in the Russell 3000 index. The Russell 3000 measures the performance of the largest 3,000 U.S. companies that represent approximately 97% of the investable U.S. equity market. The data used was a sample of a large set of U.S. companies during the "Stock Market Shock" if early 2022.

First we collected stock data from multiple datasets from WRDS website. We collected variables such as stock returns, financial ratios, Fama-French factor return data, industry identifiers, amongts other variables.

We determined the risk exposures of the stocks by calculating the Fama-French exposures: market risk exposure, size risk exposure and value/distress risk exposure. We also calculated financial ratios and industry indicators as well as handled missing values and outliers throughout the analysis. In order to deal with missing values, we used the average value for numeric columns wherever necessary. For outliers, we winsorized the data.

Finally, we ran 4 regressions based on our previous categories: risk, financial characteristics, industry dummies and a combined regression. The regressions showed that industry indicators explained most of the variance in the stocks' return, based on R-squared, compared to the other explanatory characteristics.

Recommendation

Based on the results from the regressions and our overall analysis I can recommend the following:

- Invest/Buy Energy Sector ; Avoid Semiconductors Sector and Consumer Durables & Apparel Sector
- Diversify your portfolio; Just because the energy sector showed the highest return mean that you should only invest in Energy sector. The stock market is very volatile and hard to predict, there are too many factors outside of the variables in the regressions that we did not contemplate. Diversifying the portfolio allows you to reduce the portfolio risk so that one asset performance does not affect your entire portfolio
- Re-tune your model and add other factors if possible. For ratios, the best performing one appear to be ROA, EBIT-to-Price ratio and Book-to-Price ratio

Converting to pdf

In [310]:
```
! jupyter nbconvert --to html /content/drive/MyDrive/BA870/BA870Project_
JacintoLemarroy.ipynb
```

```
[NbConvertApp] WARNING | pattern '/content/drive/MyDrive/BA870/BA870Pro
ject_JacintoLemarroy.ipynb' matched no files
This application is used to convert notebook files (*.ipynb)
        to various other formats.

        WARNING: THE COMMANDLINE INTERFACE MAY CHANGE IN FUTURE RELEASE
S.

Options
=======
The options below are convenience aliases to configurable class-option
s,
as listed in the "Equivalent to" description-line of the aliases.
To see all configurable class-options for some <cmd>, use:
    <cmd> --help-all

--debug
    set log level to logging.DEBUG (maximize logging output)
    Equivalent to: [--Application.log_level=10]
--show-config
    Show the application's configuration (human-readable format)
    Equivalent to: [--Application.show_config=True]
--show-config-json
    Show the application's configuration (json format)
    Equivalent to: [--Application.show_config_json=True]
--generate-config
    generate default config file
    Equivalent to: [--JupyterApp.generate_config=True]
-y
    Answer yes to any questions instead of prompting.
    Equivalent to: [--JupyterApp.answer_yes=True]
--execute
    Execute the notebook prior to export.
    Equivalent to: [--ExecutePreprocessor.enabled=True]
--allow-errors
    Continue notebook execution even if one of the cells throws an erro
r and include the error message in the cell output (the default behavio
ur is to abort conversion). This flag is only relevant if '--execute' w
as specified, too.
    Equivalent to: [--ExecutePreprocessor.allow_errors=True]
--stdin
    read a single notebook file from stdin. Write the resulting noteboo
k with default basename 'notebook.*'
    Equivalent to: [--NbConvertApp.from_stdin=True]
--stdout
    Write notebook output to stdout instead of files.
    Equivalent to: [--NbConvertApp.writer_class=StdoutWriter]
--inplace
    Run nbconvert in place, overwriting the existing notebook (only
            relevant when converting to notebook format)
    Equivalent to: [--NbConvertApp.use_output_suffix=False --NbConvertA
pp.export_format=notebook --FilesWriter.build_directory=]
--clear-output
    Clear output of current file and save in place,
            overwriting the existing notebook.
    Equivalent to: [--NbConvertApp.use_output_suffix=False --NbConvertA
pp.export_format=notebook --FilesWriter.build_directory= --ClearOutputP
```

```
reprocessor.enabled=True]
--no-prompt
    Exclude input and output prompts from converted document.
    Equivalent to: [--TemplateExporter.exclude_input_prompt=True --Temp
lateExporter.exclude_output_prompt=True]
--no-input
    Exclude input cells and output prompts from converted document.
            This mode is ideal for generating code-free reports.
    Equivalent to: [--TemplateExporter.exclude_output_prompt=True --Tem
plateExporter.exclude_input=True]
--log-level=<Enum>
    Set the log level by value or name.
    Choices: any of [0, 10, 20, 30, 40, 50, 'DEBUG', 'INFO', 'WARN', 'E
RROR', 'CRITICAL']
    Default: 30
    Equivalent to: [--Application.log_level]
--config=<Unicode>
    Full path of a config file.
    Default: ''
    Equivalent to: [--JupyterApp.config_file]
--to=<Unicode>
    The export format to be used, either one of the built-in formats
            ['asciidoc', 'custom', 'html', 'latex', 'markdown', 'notebo
ok', 'pdf', 'python', 'rst', 'script', 'slides']
            or a dotted object name that represents the import path for
an
            `Exporter` class
    Default: 'html'
    Equivalent to: [--NbConvertApp.export_format]
--template=<Unicode>
    Name of the template file to use
    Default: ''
    Equivalent to: [--TemplateExporter.template_file]
--writer=<DottedObjectName>
    Writer class used to write the
                                        results of the conversion
    Default: 'FilesWriter'
    Equivalent to: [--NbConvertApp.writer_class]
--post=<DottedOrNone>
    PostProcessor class used to write the
                                        results of the conversion
    Default: ''
    Equivalent to: [--NbConvertApp.postprocessor_class]
--output=<Unicode>
    overwrite base name use for output files.
                can only be used when converting one notebook at a tim
e.
    Default: ''
    Equivalent to: [--NbConvertApp.output_base]
--output-dir=<Unicode>
    Directory to write output(s) to. Defaults
                                    to output to the directory of each no
tebook. To recover
                                    previous default behaviour (outputtin
g to the current
                                    working directory) use . as the flag
value.
```

```
    Default: ''
    Equivalent to: [--FilesWriter.build_directory]
--reveal-prefix=<Unicode>
    The URL prefix for reveal.js (version 3.x).
            This defaults to the reveal CDN, but can be any url pointin
g to a copy
            of reveal.js.
            For speaker notes to work, this must be a relative path to
a local
            copy of reveal.js: e.g., "reveal.js".
            If a relative path is given, it must be a subdirectory of t
he
            current directory (from which the server is run).
            See the usage documentation
            (https://nbconvert.readthedocs.io/en/latest/usage.html#reve
al-js-html-slideshow)
            for more details.
    Default: ''
    Equivalent to: [--SlidesExporter.reveal_url_prefix]
--nbformat=<Enum>
    The nbformat version to write.
            Use this to downgrade notebooks.
    Choices: any of [1, 2, 3, 4]
    Default: 4
    Equivalent to: [--NotebookExporter.nbformat_version]

Examples
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    The simplest way to use nbconvert is

            > jupyter nbconvert mynotebook.ipynb

            which will convert mynotebook.ipynb to the default format
(probably HTML).

            You can specify the export format with `--to`.
            Options include ['asciidoc', 'custom', 'html', 'latex', 'ma
rkdown', 'notebook', 'pdf', 'python', 'rst', 'script', 'slides'].

            > jupyter nbconvert --to latex mynotebook.ipynb

            Both HTML and LaTeX support multiple output templates. LaTe
X includes
            'base', 'article' and 'report'.  HTML includes 'basic' and
'full'. You
            can specify the flavor of the format used.

            > jupyter nbconvert --to html --template basic mynotebook.i
pynb

            You can also pipe the output to stdout, rather than a file

            > jupyter nbconvert mynotebook.ipynb --stdout

            PDF is generated via latex
```

```
                > jupyter nbconvert mynotebook.ipynb --to pdf

                You can get (and serve) a Reveal.js-powered slideshow

                > jupyter nbconvert myslides.ipynb --to slides --post serve

                Multiple notebooks can be given at the command line in a co
        uple of
                different ways:

                > jupyter nbconvert notebook*.ipynb
                > jupyter nbconvert notebook1.ipynb notebook2.ipynb

                or you can specify the notebooks list in a config file, con
        taining::

                    c.NbConvertApp.notebooks = ["my_notebook.ipynb"]

                > jupyter nbconvert --config mycfg.py

        To see all available configurables, use `--help-all`.
```

In [305]: