Cory Peshkin Final Project

Data Bootcamp

Importing necessary files and libraries

In [1]:

```
import os
import time
import pandas as pd
import numpy as np
from datetime import datetime
import matplotlib.pyplot as plt
import matplotlib.dates as mdates
from matplotlib import gridspec
```

In [2]:

```
atickerspath = "~/Desktop/Jupyter/Final/a_share_tickers50.xlsx"
htickerspath = "~/Desktop/Jupyter/Final/h_share_tickers50.xlsx"
a_indexsnaps = "~/Desktop/Jupyter/Final/a_index_snap50.xlsx"
h_indexsnaps = "~/Desktop/Jupyter/Final/h_index_snap50.xlsx"
spotfxpath = "~/Desktop/Jupyter/Final/spot_fx_quotes.xlsx"
```

In [3]:

```
a_tickers = pd.read_excel(atickerspath)
h_tickers = pd.read_excel(htickerspath)
fx_quotes = pd.read_excel(spotfxpath)
a_snaps = pd.read_excel(a_indexsnaps)
h_snaps = pd.read_excel(h_indexsnaps)
```

In [4]:
```
a_tickers.head()
```

Out[4]:

	601939 CH Equity	601398 CH Equity	601857 CH Equity	601318 CH Equity
NaN	Official Closing Price	Official Closing Price	Official Closing Price	Official Closing Price
Dates	PX_OFFICIAL_CLOSE	PX_OFFICIAL_CLOSE	PX_OFFICIAL_CLOSE	PX_OFFICIAL_CLOSE
2012-05-21 00:00:00	NaN	NaN	NaN	NaN
2012-05-22 00:00:00	4.54	4.23	9.56	21.285
2012-05-23 00:00:00	4.5	4.18	9.56	21.105

5 rows × 219 columns

In [5]:
```
a_tickers['600030 CH Equity.1'].head(4)
```

Out[5]:
```
NaN                    Current Shares Outstanding
Dates                                  EQY_SH_OUT
2012-05-21 00:00:00                       9838.58
2012-05-22 00:00:00                       9838.58
Name: 600030 CH Equity.1, dtype: object
```

Cleaning the data

In [6]:
```
a_tickers = a_tickers.iloc[2:]
h_tickers = h_tickers.iloc[2:]
a_tickers = a_tickers.fillna(0)
h_tickers = h_tickers.fillna(0)
```

In [7]:

```
acols = a_tickers.columns.tolist()
hcols = h_tickers.columns.tolist()
acolsbase = acols[0:73]
hcolsbase = hcols[0:73]
a_tickers[acolsbase].head(4)
```

Out[7]:

	601939 CH Equity	601398 CH Equity	601857 CH Equity	601318 CH Equity	601988 CH Equity	600030 CH Equity	601998 CH Equity	600036 CH Equity	600016 CH Equity	601088 CH Equity
2012-05-21 00:00:00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.000	0.000	0.00
2012-05-22 00:00:00	4.54	4.23	9.56	21.285	2.99	13.30	4.34	11.585	4.611	26.26
2012-05-23 00:00:00	4.50	4.18	9.56	21.105	2.99	13.60	4.29	11.516	4.549	25.93
2012-05-24 00:00:00	4.49	4.19	9.51	21.020	3.00	13.44	4.25	11.408	4.444	25.98

4 rows × 73 columns

Create a list for A and H shares to represent snapshots of the index's constituents

In [8]:

```
a_snap_cols = a_snaps.columns.tolist()
h_snap_cols = h_snaps.columns.tolist()
len(a_snap_cols)
```

Out[8]:

```
16
```

In [9]:

```
alist1 = list(a_snaps[a_snap_cols[0]])
alist2 = a_snaps[a_snap_cols[1]]
alist3 = a_snaps[a_snap_cols[2]]
alist4 = a_snaps[a_snap_cols[3]]
alist5 = a_snaps[a_snap_cols[4]]
alist6 = a_snaps[a_snap_cols[5]]
alist7 = a_snaps[a_snap_cols[6]]
alist8 = a_snaps[a_snap_cols[7]]
alist9 = a_snaps[a_snap_cols[8]]
alist10 = a_snaps[a_snap_cols[9]]
alist11 = a_snaps[a_snap_cols[10]]
alist12 = a_snaps[a_snap_cols[11]]
alist13 = a_snaps[a_snap_cols[12]]
alist14 = a_snaps[a_snap_cols[13]]
alist15 = a_snaps[a_snap_cols[14]]
alist16 = a_snaps[a_snap_cols[15]]
```

In [10]:

```
hlist1 = list(h_snaps[h_snap_cols[0]])
hlist2 = list(h_snaps[h_snap_cols[1]])
hlist3 = list(h_snaps[h_snap_cols[2]])
hlist4 = list(h_snaps[h_snap_cols[3]])
hlist5 = list(h_snaps[h_snap_cols[4]])
hlist6 = list(h_snaps[h_snap_cols[5]])
hlist7 = list(h_snaps[h_snap_cols[6]])
hlist8 = list(h_snaps[h_snap_cols[7]])
hlist9 = list(h_snaps[h_snap_cols[8]])
hlist10 = list(h_snaps[h_snap_cols[9]])
hlist11 = list(h_snaps[h_snap_cols[10]])
hlist12 = list(h_snaps[h_snap_cols[11]])
hlist13 = list(h_snaps[h_snap_cols[12]])
hlist14 = list(h_snaps[h_snap_cols[13]])
hlist15 = list(h_snaps[h_snap_cols[14]])
hlist16 = list(h_snaps[h_snap_cols[15]])
```

In [11]:

```
period_start = pd.datetime(2012,6,1)
date_end = pd.datetime(2019,4,30)
count = 0
while count < 15:
    a1 = a_tickers.loc[(a_tickers.index >= period_start)&(a_tickers.index < a_snap_cols[1])]
    a2 = a_tickers.loc[(a_tickers.index >= a_snap_cols[1])&(a_tickers.index < a_snap_cols[2])]
    a3 = a_tickers.loc[(a_tickers.index >= a_snap_cols[2])&(a_tickers.index < a_snap_cols[3])]
    a4 = a_tickers.loc[(a_tickers.index >= a_snap_cols[3])&(a_tickers.index < a_snap_cols[4])]
    a5 = a_tickers.loc[(a_tickers.index >= a_snap_cols[4])&(a_tickers.index < a_snap_cols[5])]
    a6 = a_tickers.loc[(a_tickers.index >= a_snap_cols[5])&(a_tickers.index < a_snap_cols[6])]
    a7 = a_tickers.loc[(a_tickers.index >= a_snap_cols[6])&(a_tickers.index < a_snap_cols[7])]
    a8 = a_tickers.loc[(a_tickers.index >= a_snap_cols[7])&(a_tickers.index < a_snap_cols[8])]
    a9 = a_tickers.loc[(a_tickers.index >= a_snap_cols[8])&(a_tickers.index < a_snap_cols[9])]
    a10 = a_tickers.loc[(a_tickers.index >= a_snap_cols[9])&(a_tickers.index < a_snap_cols[10])]
    a11 = a_tickers.loc[(a_tickers.index >= a_snap_cols[10])&(a_tickers.index < a_snap_cols[11])]
    a12 = a_tickers.loc[(a_tickers.index >= a_snap_cols[11])&(a_tickers.index < a_snap_cols[12])]
    a13 = a_tickers.loc[(a_tickers.index >= a_snap_cols[12])&(a_tickers.index < a_snap_cols[13])]
    a14 = a_tickers.loc[(a_tickers.index >= a_snap_cols[13])&(a_tickers.index < a_snap_cols[14])]
    a15 = a_tickers.loc[(a_tickers.index >= a_snap_cols[14])&(a_tickers.index < date_end)]
    count = count + 1
```

In [12]:

```
h1 = h_tickers.loc[(h_tickers.index >= period_start)&(h_tickers.index < h_snap_cols[1])]
h2 = h_tickers.loc[(h_tickers.index >= h_snap_cols[1])&(h_tickers.index < h_snap_cols[2])]
h3 = h_tickers.loc[(h_tickers.index >= h_snap_cols[2])&(h_tickers.index < h_snap_cols[3])]
h4 = h_tickers.loc[(h_tickers.index >= h_snap_cols[3])&(h_tickers.index < h_snap_cols[4])]
h5 = h_tickers.loc[(h_tickers.index >= h_snap_cols[4])&(h_tickers.index < h_snap_cols[5])]
h6 = h_tickers.loc[(h_tickers.index >= h_snap_cols[5])&(h_tickers.index < h_snap_cols[6])]
h7 = h_tickers.loc[(h_tickers.index >= h_snap_cols[6])&(h_tickers.index < h_snap_cols[7])]
h8 = h_tickers.loc[(h_tickers.index >= h_snap_cols[7])&(h_tickers.index < h_snap_cols[8])]
h9 = h_tickers.loc[(h_tickers.index >= h_snap_cols[8])&(h_tickers.index < h_snap_cols[9])]
h10 = h_tickers.loc[(h_tickers.index >= h_snap_cols[9])&(h_tickers.index < h_snap_cols[10])]
h11 = h_tickers.loc[(h_tickers.index >= h_snap_cols[10])&(h_tickers.index < h_snap_cols[11])]
h12 = h_tickers.loc[(h_tickers.index >= h_snap_cols[11])&(h_tickers.index < h_snap_cols[12])]
h13 = h_tickers.loc[(h_tickers.index >= h_snap_cols[12])&(h_tickers.index < h_snap_cols[13])]
h14 = h_tickers.loc[(h_tickers.index >= h_snap_cols[13])&(h_tickers.index < h_snap_cols[14])]
h15 = h_tickers.loc[(h_tickers.index >= h_snap_cols[14])&(h_tickers.index < date_end)]
```

In [13]:

```
ah_index = pd.DataFrame()
a_list = [a1, a2, a3, a4, a5, a6, a7, a8, a9, a10, a11, a12, a13, a14, a15]
h_list = [h1, h2, h3, h4, h5, h6, h7, h8, h9, h10, h11, h12, h13, h14, h15]
a_lister = [alist1, alist2, alist3, alist4, alist5, alist6, alist7, alist8, alist9, alist10, alist11, alist12, alist13, alist14, alist15]
h_lister = [hlist1, hlist2, hlist3, hlist4, hlist5, hlist6, hlist7, hlist8, hlist9, hlist10, hlist11, hlist12, hlist13, hlist14, hlist15]
```

In [14]:

```
#generate OS column list for replacement
a_os_list = []
for indv_list in a_lister:
    indv_list = [i + ".1" for i in indv_list]
    a_os_list.append(indv_list)

h_os_list = []
for indv_list in h_lister:
    indv_list = [i + ".1" for i in indv_list]
    h_os_list.append(indv_list)

#generate FF column list for replacement
a_ff_list = []
for indv_list in a_lister:
    indv_list = [i + ".2" for i in indv_list]
    a_ff_list.append(indv_list)

h_ff_list = []
for indv_list in h_lister:
    indv_list = [i + ".2" for i in indv_list]
    h_ff_list.append(indv_list)
```

In [15]:

```
print(len(a_os_list[1]),len(a_os_list[6]))
# i.e. max holdings
```

```
50 50
```

In [16]:

```
print(a1.shape, a4.shape, a8.shape, a11.shape)
```

```
(70, 219) (94, 219) (51, 219) (238, 219)
```

In [17]:

```
print(h1.shape, h4.shape, h8.shape, h11.shape)
```

```
(70, 219) (94, 219) (51, 219) (238, 219)
```

In [18]:

```
fx_quotes.head(4)
```

Out[18]:

	Dates	USDCNY Curncy	USDHKD Curncy
0	2012-05-01	6.2774	7.7582
1	2012-05-02	6.3075	7.7587
2	2012-05-03	6.3053	7.7593
3	2012-05-04	6.3061	7.7608

Function to generate the AH Premium using cleaned and prepared files as inputs

In [19]:

```
count = 0
final_indiv = pd.DataFrame()
ah_rep_index = pd.DataFrame()
for adf, hdf in zip(a_list, h_list):
# have to reset matricies for FX conversion
    fx_quotes = pd.read_excel(spotfxpath)
    fx_quotes = fx_quotes.set_index('Dates')
    a_prem = pd.DataFrame()
    h_prem = pd.DataFrame()

    adfcols = adf.columns.tolist()
    hdfcols = hdf.columns.tolist()
    adfcolsbase = adfcols[0:73]
    hdfcolsbase = adfcolsbase

#split across all tickers
    adf_colspx = adfcols[0:73]
    hdf_colspx = hdfcols[0:73]
    adf_colsos = adfcols[73:146]
    hdf_colsos = hdfcols[73:146]
    adf_colsff = adfcols[146:219]
    hdf_colsff = hdfcols[146:219]
    a_px = adf[adf_colspx]
    a_os = adf[adf_colsos]
    a_ff = adf[adf_colsff]
    h_px = hdf[hdf_colspx]
    h_os = hdf[hdf_colsos]
    h_ff = hdf[hdf_colsff]


#split w/ new name for time-senstitive tickers
    a_px = a_px[a_lister[count]]
    a_os = a_os[a_os_list[count]]
    a_ff = a_ff[a_ff_list[count]]
    h_px = h_px[h_lister[count]]
    h_os = h_os[h_os_list[count]]
    h_ff = h_ff[h_ff_list[count]]

#Correct for Bloomberg Units
    a_os = a_os.multiply(1000)
    h_os = h_os.multiply(1000)
    a_ff = a_ff.div(100)
    h_ff = h_ff.div(100)
```

```
#Check for missing rows
    dataset_ah = (a_px, a_os, a_ff, h_px, h_os, h_ff)
    for df in dataset_ah:
        null_df = df[df.isnull().any(axis=1)]
        if len(null_df) != 0:
            print("Missing values in a dataframe")

    a_flos_adj = (a_os.values * a_ff.values)
    h_flos_adj = (h_os.values * h_ff.values)
    adj_flos = a_flos_adj + h_flos_adj

    numerator = adj_flos * a_px.values
    denominator = adj_flos * h_px.values
    numerator = pd.DataFrame(data = numerator, index=a_os.index, colum
ns=a_px.columns)
    denominator = pd.DataFrame(data = denominator, index=h_os.index, c
olumns=h_px.columns)

#slicing only the dates we need for the fx spot matrix
    fx_dates = fx_quotes.index.tolist()
    dates = numerator.index.tolist()
    excessfx = []
    excessfx = np.setdiff1d(fx_dates, dates)
    print(len(fx_quotes),len(excessfx),len(fx_quotes)-len(excessfx),le
n(numerator))
    fx_quotes = fx_quotes.drop(excessfx,0)
    usdcny = fx_quotes.drop('USDHKD Curncy', axis = 1)
    usdhkd = fx_quotes.drop('USDCNY Curncy', axis = 1)

    for cols in numerator.columns:
        usdcny[cols] = usdcny['USDCNY Curncy']
    for cols in denominator.columns:
        usdhkd[cols] = usdhkd['USDHKD Curncy']
#Remove reference column which we duplicated from
    usdcny = usdcny.drop('USDCNY Curncy', axis = 1)
    usdhkd = usdhkd.drop('USDHKD Curncy', axis = 1)

    a_prem_cny = numerator.values / usdcny.values
    h_prem_hkd = denominator.values / usdhkd.values
    ah_prem = a_prem_cny / h_prem_hkd
    ah_prem = pd.DataFrame(data=ah_prem, index=usdcny.index, columns=r
ange(1,51))

    a_v = pd.DataFrame(data=a_prem_cny, index=usdcny.index, columns=ra
nge(1,51))
    h_v = pd.DataFrame(data=h_prem_hkd, index=usdcny.index, columns=ra
nge(1,51))
    a_v['Sum'] = a_v.sum(axis = 1)
    h_v['Sum'] = h_v.sum(axis = 1)
    a_v = a_v['Sum']
    h_v = h_v['Sum']

    ah_index = a_v/h_v

    ah_rep_index = ah_rep_index.append(ah_index, ignore_index=False)

    final_indiv = final_indiv.append(ah_prem)
```

```
2575 2505 70 70
2575 2463 112 112
2575 2542 33 33
2575 2481 94 94
2575 2458 117 117
2575 2449 126 126
2575 2458 117 117
2575 2524 51 51
2575 2496 79 79
2575 2456 119 119
2575 2337 238 238
2575 2450 125 125
2575 2456 119 119
2575 2445 130 130
2575 2423 152 152
```

In [20]:

```
type(ah_index)
```

Out[20]:

```
pandas.core.series.Series
```

In [21]:

```
ah_prem[151:152].sum(axis = 1)
```

Out[21]:

```
Dates
2019-04-29    90.015802
dtype: float64
```

In [22]:
```
final_indiv = final_indiv*100
final_indiv.head(4)
```

Out[22]:

	1	2	3	4	5	6	7	
Dates								
2012-06-01	100.931005	109.912109	117.850065	90.935340	123.880773	97.756144	19.542669	628.2
2012-06-04	101.747683	109.329231	116.766136	93.170522	124.401929	97.015800	19.830708	635.0
2012-06-05	101.200585	109.118629	117.808542	91.855502	123.075805	98.565972	20.424460	629.8
2012-06-06	100.249018	114.542906	115.003691	89.492596	130.090905	98.574685	21.172448	602.9

4 rows × 50 columns

In [23]:
```
ah_rep_index[0:1]
```

Out[23]:

	2012-06-01 00:00:00	2012-06-04 00:00:00	2012-06-05 00:00:00	2012-06-06 00:00:00	2012-06-07 00:00:00	2012-06-08 00:00:00	2012-06-11 00:00:00	2012-06-12 00:00:00	2012-06 1 00:00:0
Sum	0.989162	0.995131	0.999588	1.002028	0.994209	0.995558	0.978677	0.976244	0.97161

1 rows × 1682 columns

In [24]:
```
ah_rep_index[-1:]
```

Out[24]:

	2012-06-01 00:00:00	2012-06-04 00:00:00	2012-06-05 00:00:00	2012-06-06 00:00:00	2012-06-07 00:00:00	2012-06-08 00:00:00	2012-06-11 00:00:00	2012-06-12 00:00:00	2012-06-13 00:00:00	00
Sum	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

1 rows × 1682 columns

In [25]:
```
ah_rep_index.mean().head(4)
```

Out[25]:
```
2012-06-01    0.989162
2012-06-04    0.995131
2012-06-05    0.999588
2012-06-06    1.002028
dtype: float64
```

In [26]:

```
ah_rep_index.mean().tail(4)
```

Out[26]:

```
2019-04-24    1.161664
2019-04-25    1.153954
2019-04-26    1.151423
2019-04-29    1.153479
dtype: float64
```

In [27]:

```
ah_index = 100* ah_rep_index.mean()
ah_index[1]
```

Out[27]:

```
99.51311917640714
```

In [28]:

```
type(ah_index)
```

Out[28]:

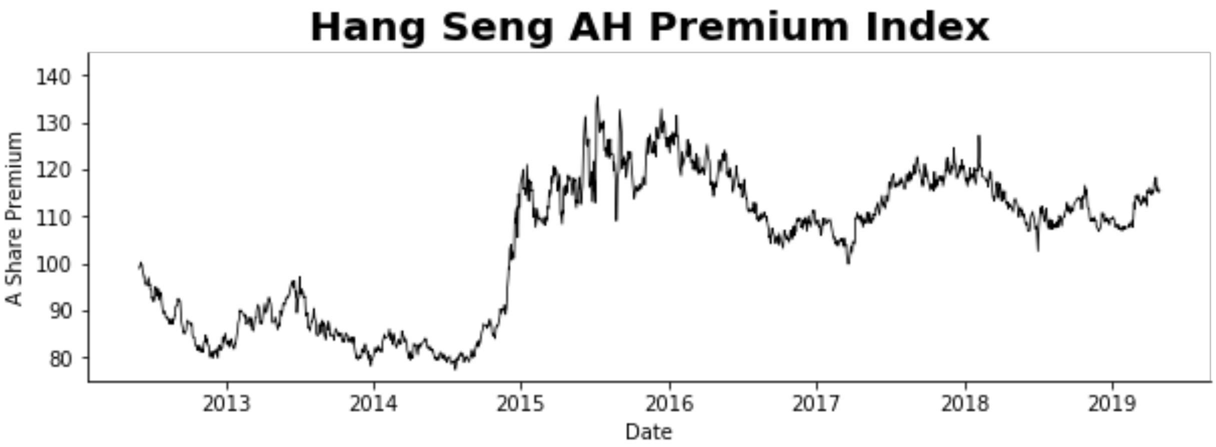
```
pandas.core.series.Series
```

In [29]:

```
fig, ax1 = plt.subplots(figsize= (10,3))
x1 = final_indiv.index.tolist()
y1 = ah_index.tolist()
#formating plot
ax1.plot(x1, y1, color = 'black', linewidth = .75)
ax1.set_title("Hang Seng AH Premium Index", fontsize = 20, fontweight
= 'bold')
ax1.set_xlabel("Date")
ax1.set_ylabel("A Share Premium")
ax1.spines["top"].set_visible(False)
ax1.spines["right"].set_visible(False)
ax1.set_ylim(75,145)
```

Out[29]:

```
(75, 145)
```

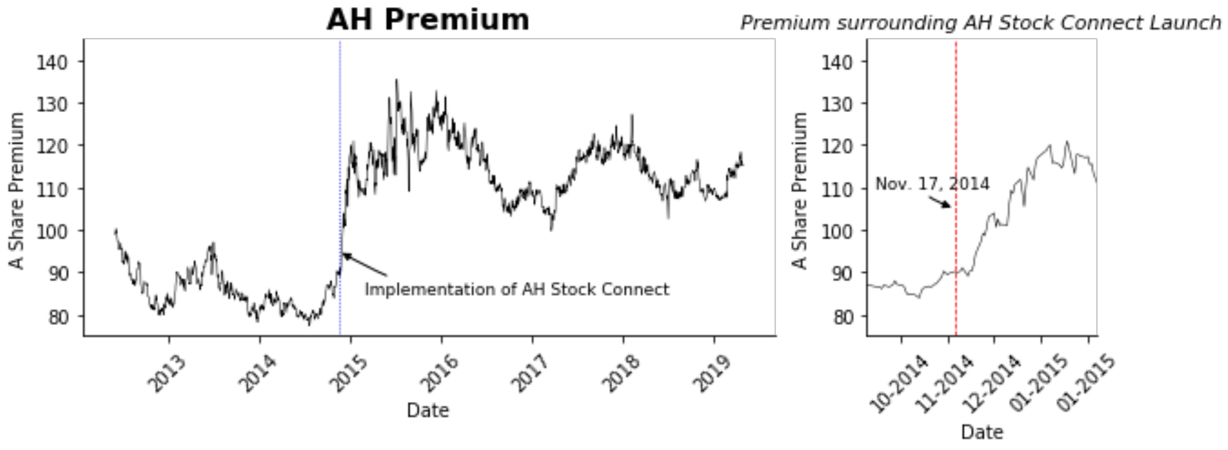


In [30]:

```
fig, (ax1, ax2) = plt.subplots(nrows = 1, ncols = 2, figsize= (10,3))
gs = gridspec.GridSpec(1,2,width_ratios = [3,1])
ax1 = plt.subplot(gs[0])
```

```
ax2 = plt.subplot(gs[1])
x1 = ah_index.index.tolist()
y1 = ah_index.tolist()
#formating plot
ax1.plot(x1, y1, color = 'black', linewidth = .5)
ax1.set_title("AH Premium", fontsize = 16, fontweight = 'bold')
ax1.set_xlabel("Date")
ax1.set_ylabel("A Share Premium")
ax1.spines["top"].set_visible(False)
ax1.spines["right"].set_visible(False)
ax1.set_ylim(75,145)

#add AH Stock Connect start line
ax1.axvline(datetime(2014,11,17), linestyle = 'dotted', color = 'blue'
, linewidth = .75)
#add annotations to first plot
ax1.annotate(
    "Implementation of AH Stock Connect",
    xy = (datetime(2014,11,17), 95),
    xytext = (datetime(2015,3,1),85),
    arrowprops={
        "arrowstyle": "-|>",
        "connectionstyle": "angle3,angleA=25,angleB=150",
        "color": "black"
        },
    fontsize=9,
)

x2 = ah_index.index.tolist()
y2 = ah_index.tolist()
ax2.plot(x1, y1, color = 'black', linewidth = .5)

#formating plot
ax2.set_title("Premium surrounding AH Stock Connect Launch", fontsize
= 11, fontstyle = 'oblique')
ax2.set_xlabel("Date")
ax2.set_ylabel("A Share Premium")
ax2.spines["top"].set_visible(False)
ax2.spines["right"].set_visible(False)
ax2.set_ylim(75,145)
ax2.set_xlim(datetime(2014,10,1),datetime(2015,2,1))

#change axis labels to months
months = mdates.MonthLocator()
months_fmt = mdates.DateFormatter('%m-%Y')
ax2.xaxis.set_major_locator(months)
ax2.xaxis.set_major_formatter(months_fmt)
ax2.xaxis.set_major_locator(plt.MaxNLocator(5))

#add AH Stock Connect start line
```

```python
ax2.axvline(datetime(2014,11,17), linestyle = 'dashed', color = 'red',
linewidth = .75)

#add annotations to second plot
ax2.annotate(
    "Nov. 17, 2014",
    xy = (datetime(2014,11,17), 105),
    xytext = (datetime(2014,10,5),110),
    arrowprops={
        "arrowstyle": "-|>",
        "connectionstyle": "angle3,angleA=20,angleB=160",
        "color": "black"
        },
    fontsize=9,
)
for ax in fig.axes:
    plt.sca(ax)
    plt.xticks(rotation=45)
```



In [31]:
```python
ah_df = pd.DataFrame(data = ah_index, index = ah_index.index)
ah_df.columns = ['Index']
ah_df.head(4)
```

Out[31]:

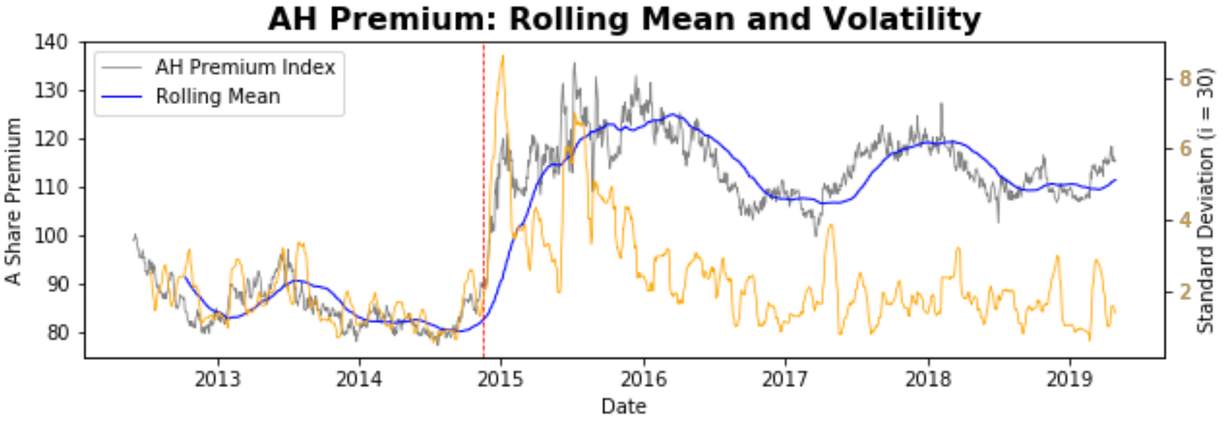
	Index
2012-06-01	98.916186
2012-06-04	99.513119
2012-06-05	99.958836
2012-06-06	100.202850

In [32]:
```python
ah_df['Rolling StDev'] = ah_df['Index'].rolling(window = 30).std()
ah_df['Rolling Mean'] = ah_df['Index'].rolling(window = 90).mean()
```

In [33]:

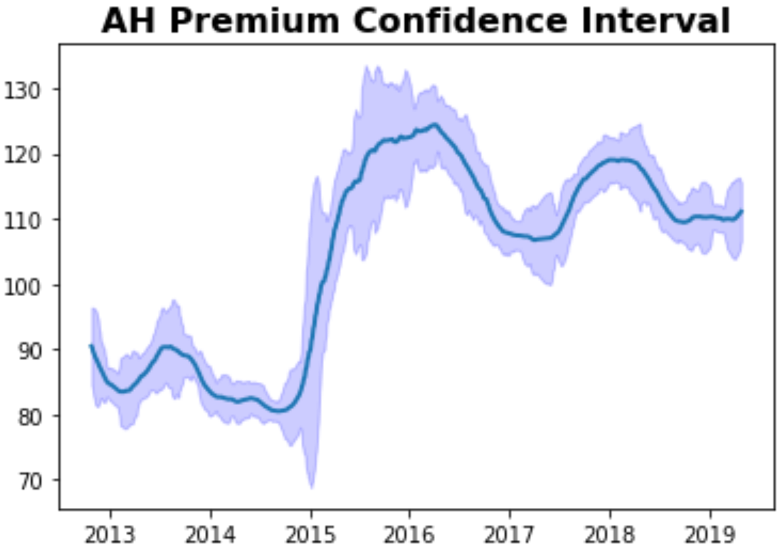
```
fig, ax1 = plt.subplots(figsize= (10,3))
x1 = final_indiv.index.tolist()
y1 = ah_index.tolist()
x2 = ah_df.index.tolist()
y2 = ah_df['Rolling Mean'].tolist()
x3 = x2
y3 = ah_df['Rolling StDev'].tolist()
#formating plot
ax1.plot(x1, y1, label = "AH Premium Index", color = 'grey', linewidth
= .75)
ax1.plot(x2, y2, label = "Rolling Mean", color = 'blue', linewidth = 1
)


ax1.set_title("AH Premium: Rolling Mean and Volatility", fontsize = 16
, fontweight = 'bold')
ax1.set_xlabel("Date")
ax1.set_ylabel("A Share Premium")
ax1.spines["top"].set_visible(False)
ax2.spines["top"].set_visible(False)
ax1.set_ylim(75,140)

#add AH Stock Connect start line
ax1.axvline(datetime(2014,11,17), linestyle = 'dashed', color = 'red',
linewidth = .75)
#add annotations to first plot
ax1.annotate(
    "Implementation of AH Stock Connect",
    xy = (datetime(2014,11,17), 185),
    xytext = (datetime(2012,4,1),210),
    arrowprops={
        "arrowstyle": "-|>",
        "connectionstyle": "angle3,angleA=20,angleB=160",
        "color": "black"
        },
    fontsize=9,
)

#second axis
ax2 = ax1.twinx()
ax2.tick_params(axis = 'y', labelcolor = 'orange')
ax2.set_ylabel('Standard Deviation (i = 30)')
ax2.plot(x3, y3, color = 'orange', linewidth = 0.75)


ax1.legend(loc = 'upper left')
```

```
Out[33]: <matplotlib.legend.Legend at 0x121b06ac8>
```


AH Premium: Rolling Mean and Volatility
AH Premium Index
Rolling Mean
A Share Premium
140
130
120
110
100
90
80
2013
2014
2015
2016
2017
2018
2019
Date
Standard Deviation (i = 30)
8
6
4
2

```
In [34]: ah_df = pd.DataFrame(data = ah_index, index = ah_index.index)
         smooth = ah_df.rolling(100).mean()
         path_interval = ah_df.rolling(50).std()
         plt.plot(smooth, linewidth = 2)
         plt.fill_between(path_interval.index, (smooth-2*path_interval)[0],(smooth+2*path_interval)[0], color = 'b', alpha = 0.2)
         plt.title('AH Premium Confidence Interval', fontsize = 16, fontweight = 'bold')
```

```
Out[34]: Text(0.5, 1.0, 'AH Premium Confidence Interval')
```



In [35]:

```
heavy = [1, 2, 3, 4 , 5]
light = [46, 47, 48, 49, 50]
heaviest10pct = final_indiv[heavy]
lightest10pct = final_indiv[light]
heaviest10pct['Net'] = heaviest10pct.sum(axis = 1)/5
lightest10pct['Net'] = lightest10pct.sum(axis = 1)/5
heaviest10pct = heaviest10pct['Net']
lightest10pct = lightest10pct['Net']
type(heaviest10pct)
```

```
/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:5: Sett
ingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/panda
s-docs/stable/indexing.html#indexing-view-versus-copy
  """
/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:6: Sett
ingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/panda
s-docs/stable/indexing.html#indexing-view-versus-copy
```

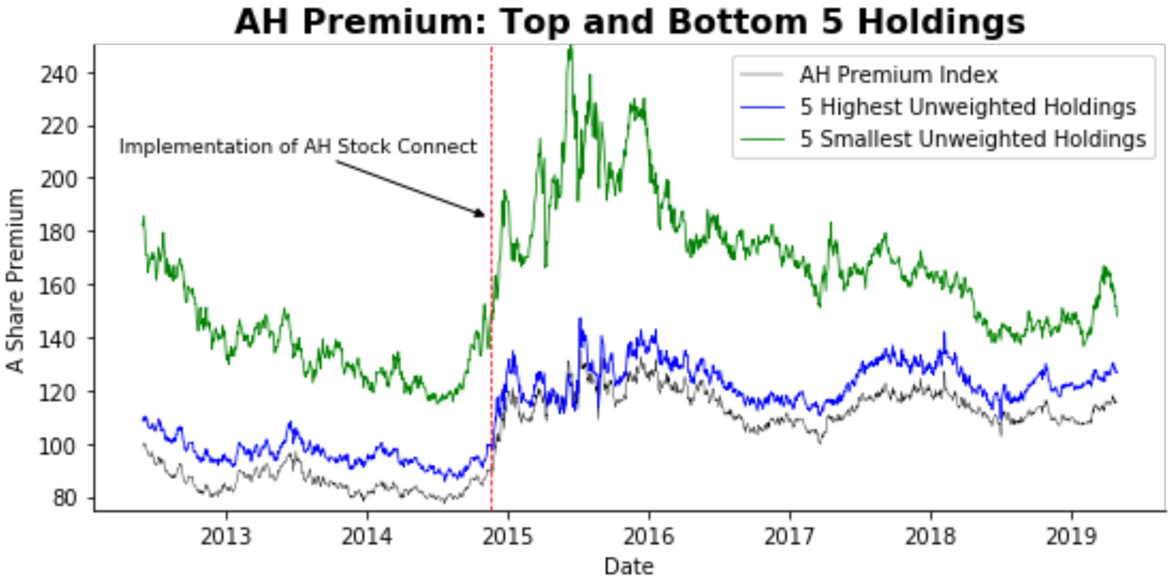
Out[35]:

```
pandas.core.series.Series
```

In [36]:

```
fig, ax1 = plt.subplots(figsize= (9,4))
x1 = final_indiv.index.tolist()
y1 = ah_index.tolist()
x2 = heaviest10pct.index.tolist()
y2 = heaviest10pct.tolist()
x3 = lightest10pct.index.tolist()
y3 = lightest10pct.tolist()
#formating plot
ax1.plot(x1, y1, label = "AH Premium Index", color = 'black', linewidth = .375)
ax1.plot(x2, y2, label = "5 Highest Unweighted Holdings", color = 'blue', linewidth = .75)
ax1.plot(x3, y3, label = "5 Smallest Unweighted Holdings", color = 'green', linewidth = .75)
ax1.set_title("AH Premium: Top and Bottom 5 Holdings", fontsize = 16, fontweight = 'bold')
ax1.set_xlabel("Date")
ax1.set_ylabel("A Share Premium")
ax1.spines["top"].set_visible(False)
ax1.spines["right"].set_visible(False)
ax1.set_ylim(75,250)

#add AH Stock Connect start line
ax1.axvline(datetime(2014,11,17), linestyle = 'dashed', color = 'red', linewidth = .75)
#add annotations to first plot
ax1.annotate(
    "Implementation of AH Stock Connect",
    xy = (datetime(2014,11,17), 185),
    xytext = (datetime(2012,4,1),210),
    arrowprops={
        "arrowstyle": "-|>",
        "connectionstyle": "angle3,angleA=20,angleB=160",
        "color": "black"
        },
    fontsize=9,
)

#handles, labels = ax1.get_legend_handles_labels()
#ax1.legend(handles, labels)
ax1.legend(loc = 'upper right')
```

```
Out[36]: <matplotlib.legend.Legend at 0x120f445f8>
```



```
In [ ]:
```

```
In [ ]:
```

```
In [ ]:
```

```
In [ ]:
```