rebalance

October 18, 2019

In [2]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
```

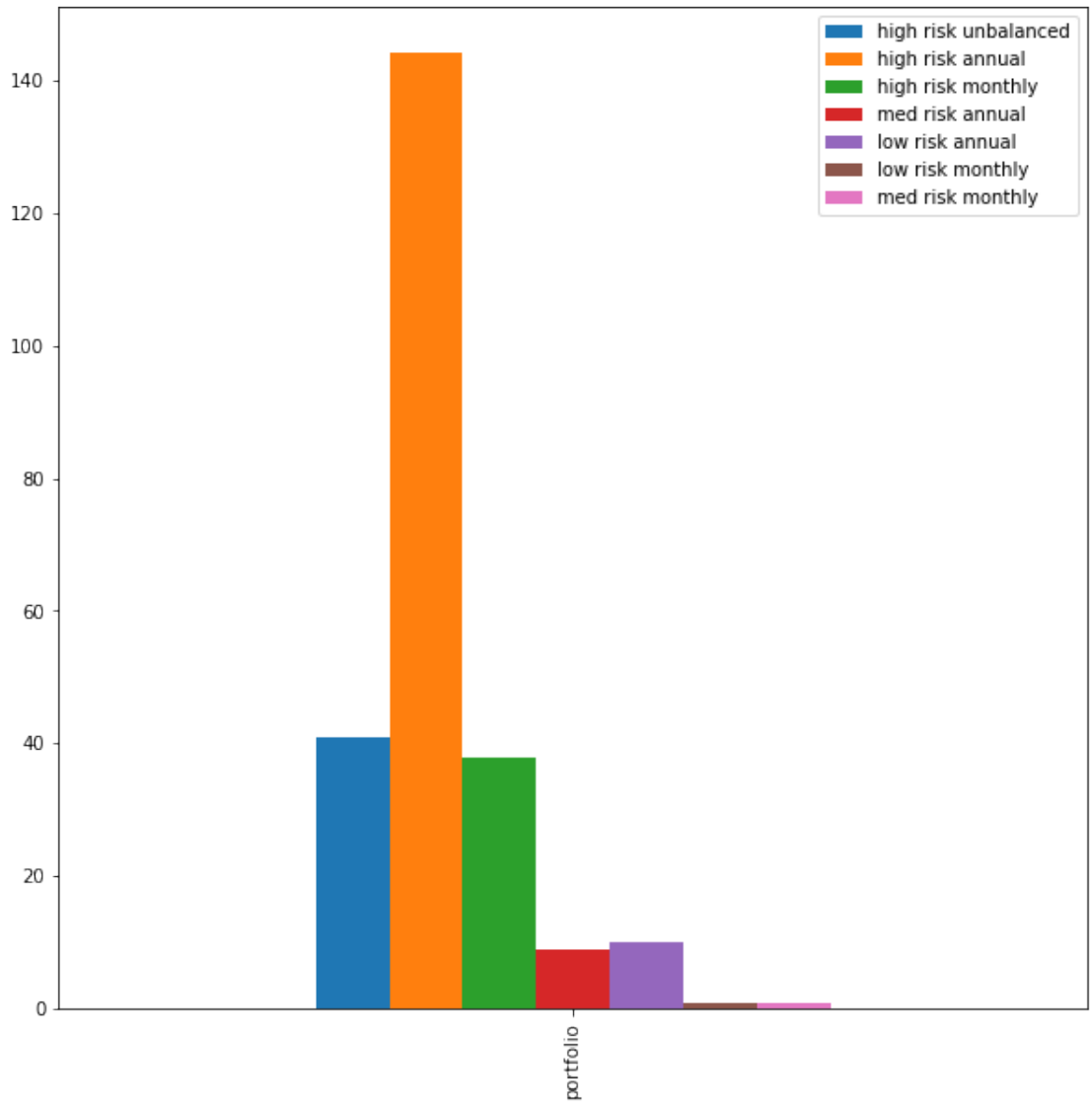
In [3]:
```
##create dataframe of percent increases
df = pd.read_csv("pandas_data.csv", index_col=0)

#convert final monetary value data to percent gained
df = df.div(10).mul(100)
df = df.round(3)
```

In [4]:
```
#create dict where key = port and val = # of times best
best_port_dict = {}
for column in df:
    best = df[column].idxmax()
    if best in best_port_dict:
        best_port_dict[best] += 1
    else:
        best_port_dict[best] = 1

df_best = pd.DataFrame(best_port_dict, index=["portfolio"])
df_best.plot.bar(figsize=(10,10))
```

Out[4]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f01cafe6c18>
```




```
In [5]: best_port=[]
        port = {}
        #create list of tuples, form (port, % of time best)
        for key in best_port_dict:
            val= best_port_dict[key]/244
            best_port.append((key,val))
        #reverse sort (highest ranking first)
        best_port.sort(key=lambda x: x[1], reverse=True)
        #display as percentage
        for (i,j) in best_port:
            port[i] ='{:.2%}'.format(j)
        #create and show as dataframe
        df_comp = pd.DataFrame(port, index=['frequency of being best'])
```

In [6]:
```
df = df.transpose()
df.to_csv('value.csv')
df
```

Out[6]:

	low risk unbalanced	med risk unbalanced	\
1/1/1979 - 12/31/1998	1037.111	1272.497	
2/1/1979 - 1/29/1999	1026.767	1260.329	
3/1/1979 - 2/26/1999	1017.492	1250.727	
4/1/1979 - 3/31/1999	1005.934	1233.545	
5/1/1979 - 4/30/1999	1028.136	1268.552	
6/1/1979 - 5/31/1999	1014.664	1257.756	
7/1/1979 - 6/30/1999	1010.922	1261.821	
8/1/1979 - 7/30/1999	988.678	1226.719	
9/1/1979 - 8/31/1999	958.586	1175.776	
10/1/1979 - 9/30/1999	953.143	1157.670	
11/1/1979 - 10/29/1999	1050.370	1291.177	
12/1/1979 - 11/30/1999	1027.350	1265.570	
1/1/1980 - 12/31/1999	1046.803	1301.304	
2/1/1980 - 1/31/2000	997.926	1207.902	
3/1/1980 - 2/29/2000	1035.371	1236.971	
4/1/1980 - 3/31/2000	1147.451	1417.976	
5/1/1980 - 4/28/2000	1041.137	1291.109	
6/1/1980 - 5/31/2000	979.009	1207.223	
7/1/1980 - 6/30/2000	977.266	1203.557	
8/1/1980 - 7/31/2000	949.329	1144.521	
9/1/1980 - 8/31/2000	989.802	1189.873	
10/1/1980 - 9/29/2000	957.802	1129.005	
11/1/1980 - 10/31/2000	950.107	1107.954	
12/1/1980 - 11/30/2000	893.429	1005.084	
1/1/1981 - 12/29/2000	905.660	1029.590	
2/1/1981 - 1/31/2001	940.663	1080.611	
3/1/1981 - 2/28/2001	912.660	1020.685	
4/1/1981 - 3/30/2001	863.979	948.607	
5/1/1981 - 4/30/2001	910.290	1010.218	
6/1/1981 - 5/31/2001	897.332	1002.963	
...	...	...	
11/1/1996 - 10/31/2016	311.180	330.460	
12/1/1996 - 11/30/2016	301.121	321.048	
1/1/1997 - 12/30/2016	306.925	328.846	
2/1/1997 - 1/31/2017	304.911	325.705	
3/1/1997 - 2/28/2017	308.781	331.424	
4/1/1997 - 3/31/2017	315.570	340.859	
5/1/1997 - 4/28/2017	311.423	335.255	
6/1/1997 - 5/31/2017	304.388	323.866	
7/1/1997 - 6/30/2017	298.004	315.509	
8/1/1997 - 7/31/2017	289.918	305.933	
9/1/1997 - 8/31/2017	298.088	316.531	
10/1/1997 - 9/29/2017	291.520	308.972	

11/1/1997 - 10/31/2017	296.348	319.395
12/1/1997 - 11/30/2017	295.600	319.156
1/1/1998 - 12/29/2017	294.014	317.442
2/1/1998 - 1/31/2018	293.896	321.292
3/1/1998 - 2/28/2018	280.283	300.044
4/1/1998 - 3/30/2018	274.498	289.939
5/1/1998 - 4/30/2018	272.441	288.574
6/1/1998 - 5/31/2018	276.247	295.303
7/1/1998 - 6/29/2018	272.267	290.225
8/1/1998 - 7/31/2018	277.330	298.976
9/1/1998 - 8/31/2018	297.953	334.894
10/1/1998 - 9/28/2018	287.447	321.975
11/1/1998 - 10/31/2018	268.973	291.597
12/1/1998 - 11/30/2018	264.807	284.613
1/1/1999 - 12/31/2018	253.505	263.461
2/1/1999 - 1/31/2019	259.087	272.240
3/1/1999 - 2/28/2019	269.210	286.459
4/1/1999 - 3/29/2019	268.683	283.452

	high risk unbalanced	low risk monthly \
1/1/1979 - 12/31/1998	1507.883	941.715
2/1/1979 - 1/29/1999	1493.892	930.471
3/1/1979 - 2/26/1999	1483.963	918.844
4/1/1979 - 3/31/1999	1461.156	911.691
5/1/1979 - 4/30/1999	1508.968	925.924
6/1/1979 - 5/31/1999	1500.849	908.341
7/1/1979 - 6/30/1999	1512.719	897.346
8/1/1979 - 7/30/1999	1464.760	887.297
9/1/1979 - 8/31/1999	1392.965	873.459
10/1/1979 - 9/30/1999	1362.197	879.222
11/1/1979 - 10/29/1999	1531.985	953.142
12/1/1979 - 11/30/1999	1503.791	932.308
1/1/1980 - 12/31/1999	1555.806	940.121
2/1/1980 - 1/31/2000	1417.878	925.609
3/1/1980 - 2/29/2000	1438.571	978.137
4/1/1980 - 3/31/2000	1688.501	1037.661
5/1/1980 - 4/28/2000	1541.081	936.065
6/1/1980 - 5/31/2000	1435.438	886.682
7/1/1980 - 6/30/2000	1429.847	886.972
8/1/1980 - 7/31/2000	1339.713	883.246
9/1/1980 - 8/31/2000	1389.943	918.950
10/1/1980 - 9/29/2000	1300.208	907.464
11/1/1980 - 10/31/2000	1265.800	905.726
12/1/1980 - 11/30/2000	1116.740	880.917
1/1/1981 - 12/29/2000	1153.520	888.086
2/1/1981 - 1/31/2001	1220.559	912.163
3/1/1981 - 2/28/2001	1128.709	904.207
4/1/1981 - 3/30/2001	1033.236	865.272

5/1/1981 - 4/30/2001	1110.146	903.276
6/1/1981 - 5/31/2001	1108.594	887.042
...	...	...
11/1/1996 - 10/31/2016	349.739	323.077
12/1/1996 - 11/30/2016	340.976	312.027
1/1/1997 - 12/30/2016	350.767	317.586
2/1/1997 - 1/31/2017	346.499	316.653
3/1/1997 - 2/28/2017	354.067	319.710
4/1/1997 - 3/31/2017	366.148	325.535
5/1/1997 - 4/28/2017	359.087	322.065
6/1/1997 - 5/31/2017	343.343	316.510
7/1/1997 - 6/30/2017	333.014	310.165
8/1/1997 - 7/31/2017	321.948	302.597
9/1/1997 - 8/31/2017	334.974	310.650
10/1/1997 - 9/29/2017	326.423	304.053
11/1/1997 - 10/31/2017	342.442	307.373
12/1/1997 - 11/30/2017	342.713	306.447
1/1/1998 - 12/29/2017	340.869	304.939
2/1/1998 - 1/31/2018	348.688	303.133
3/1/1998 - 2/28/2018	319.806	291.665
4/1/1998 - 3/30/2018	305.380	286.900
5/1/1998 - 4/30/2018	304.707	284.651
6/1/1998 - 5/31/2018	314.359	287.101
7/1/1998 - 6/29/2018	308.182	283.183
8/1/1998 - 7/31/2018	320.621	286.678
9/1/1998 - 8/31/2018	371.835	299.366
10/1/1998 - 9/28/2018	356.503	290.544
11/1/1998 - 10/31/2018	314.221	276.404
12/1/1998 - 11/30/2018	304.420	272.933
1/1/1999 - 12/31/2018	273.418	264.758
2/1/1999 - 1/31/2019	285.392	269.796
3/1/1999 - 2/28/2019	303.708	278.582
4/1/1999 - 3/29/2019	298.222	278.710

	med risk monthly	high risk monthly	low risk annual	\
1/1/1979 - 12/31/1998	1145.099	1371.109	936.388	
2/1/1979 - 1/29/1999	1130.724	1353.062	922.355	
3/1/1979 - 2/26/1999	1116.849	1336.767	913.899	
4/1/1979 - 3/31/1999	1105.885	1320.970	908.436	
5/1/1979 - 4/30/1999	1131.414	1361.312	930.591	
6/1/1979 - 5/31/1999	1115.198	1348.245	909.798	
7/1/1979 - 6/30/1999	1110.095	1352.169	899.150	
8/1/1979 - 7/30/1999	1092.843	1325.315	898.277	
9/1/1979 - 8/31/1999	1063.454	1275.005	890.299	
10/1/1979 - 9/30/1999	1060.369	1259.310	900.022	
11/1/1979 - 10/29/1999	1163.227	1397.861	951.821	
12/1/1979 - 11/30/1999	1142.091	1377.592	933.306	
1/1/1980 - 12/31/1999	1163.493	1417.521	935.759	

2/1/1980 - 1/31/2000	1114.627	1321.648	914.908
3/1/1980 - 2/29/2000	1167.234	1371.678	968.375
4/1/1980 - 3/31/2000	1279.015	1553.314	1036.492
5/1/1980 - 4/28/2000	1155.799	1406.164	942.420
6/1/1980 - 5/31/2000	1087.809	1314.929	888.749
7/1/1980 - 6/30/2000	1087.157	1312.933	889.236
8/1/1980 - 7/31/2000	1059.572	1252.607	893.026
9/1/1980 - 8/31/2000	1096.234	1288.830	935.951
10/1/1980 - 9/29/2000	1062.115	1225.092	927.069
11/1/1980 - 10/31/2000	1046.874	1192.519	900.147
12/1/1980 - 11/30/2000	988.013	1091.925	876.123
1/1/1981 - 12/29/2000	1007.289	1125.891	885.272
2/1/1981 - 1/31/2001	1043.010	1175.334	904.606
3/1/1981 - 2/28/2001	1009.820	1111.045	901.767
4/1/1981 - 3/30/2001	949.571	1026.449	870.388
5/1/1981 - 4/30/2001	999.439	1089.048	904.549
6/1/1981 - 5/31/2001	988.173	1084.196	886.435
...	...	...	...
11/1/1996 - 10/31/2016	346.027	362.925	327.600
12/1/1996 - 11/30/2016	335.121	352.447	315.206
1/1/1997 - 12/30/2016	342.825	362.373	326.108
2/1/1997 - 1/31/2017	341.435	360.503	325.412
3/1/1997 - 2/28/2017	346.053	366.773	338.060
4/1/1997 - 3/31/2017	354.287	377.559	342.892
5/1/1997 - 4/28/2017	349.656	371.719	329.116
6/1/1997 - 5/31/2017	340.147	357.999	320.462
7/1/1997 - 6/30/2017	331.589	347.186	312.736
8/1/1997 - 7/31/2017	322.790	337.240	300.569
9/1/1997 - 8/31/2017	333.585	350.863	310.888
10/1/1997 - 9/29/2017	325.897	342.151	307.895
11/1/1997 - 10/31/2017	334.867	357.397	312.616
12/1/1997 - 11/30/2017	334.457	357.595	310.408
1/1/1998 - 12/29/2017	332.897	356.017	313.647
2/1/1998 - 1/31/2018	334.714	362.006	312.981
3/1/1998 - 2/28/2018	315.713	334.785	308.757
4/1/1998 - 3/30/2018	306.638	321.074	301.256
5/1/1998 - 4/30/2018	305.108	320.385	290.380
6/1/1998 - 5/31/2018	309.992	327.911	291.027
7/1/1998 - 6/29/2018	304.866	321.548	285.772
8/1/1998 - 7/31/2018	311.555	331.710	285.466
9/1/1998 - 8/31/2018	337.441	373.076	301.101
10/1/1998 - 9/28/2018	327.149	361.316	295.207
11/1/1998 - 10/31/2018	301.606	322.828	281.848
12/1/1998 - 11/30/2018	295.311	313.460	277.227
1/1/1999 - 12/31/2018	277.936	286.135	272.718
2/1/1999 - 1/31/2019	286.132	297.547	278.749
3/1/1999 - 2/28/2019	298.593	313.800	295.150
4/1/1999 - 3/29/2019	296.312	308.892	292.918

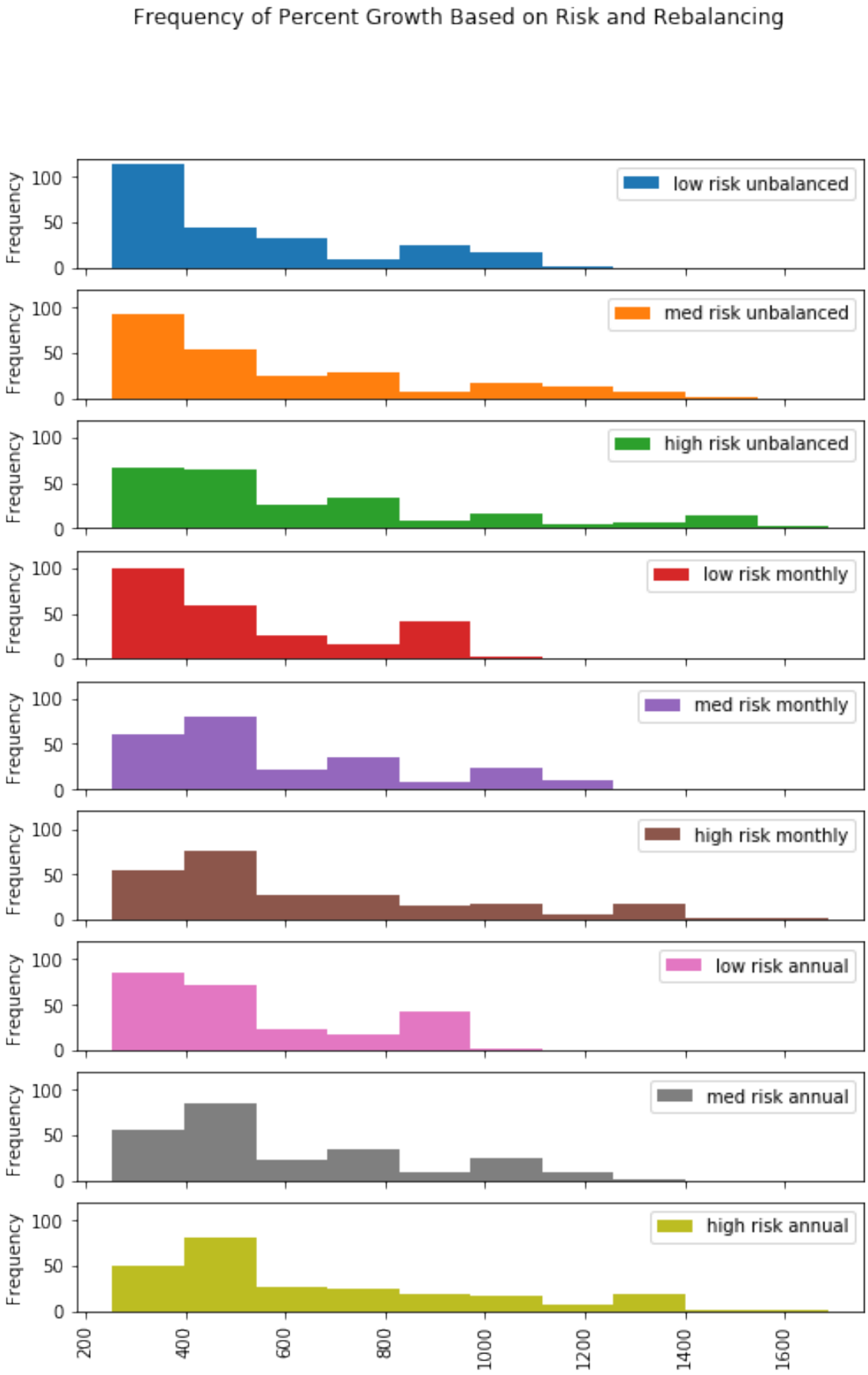
	med risk annual	high risk annual
1/1/1979 - 12/31/1998	1138.568	1368.525
2/1/1979 - 1/29/1999	1120.125	1346.640
3/1/1979 - 2/26/1999	1111.295	1336.947
4/1/1979 - 3/31/1999	1102.606	1322.824
5/1/1979 - 4/30/1999	1139.333	1374.246
6/1/1979 - 5/31/1999	1117.883	1354.156
7/1/1979 - 6/30/1999	1112.052	1354.601
8/1/1979 - 7/30/1999	1108.255	1340.963
9/1/1979 - 8/31/1999	1085.568	1294.091
10/1/1979 - 9/30/1999	1087.693	1283.168
11/1/1979 - 10/29/1999	1161.663	1398.715
12/1/1979 - 11/30/1999	1144.589	1384.063
1/1/1980 - 12/31/1999	1157.329	1413.331
2/1/1980 - 1/31/2000	1100.148	1310.490
3/1/1980 - 2/29/2000	1155.655	1366.731
4/1/1980 - 3/31/2000	1278.504	1557.343
5/1/1980 - 4/28/2000	1165.641	1419.921
6/1/1980 - 5/31/2000	1090.793	1319.913
7/1/1980 - 6/30/2000	1089.379	1314.846
8/1/1980 - 7/31/2000	1072.492	1264.558
9/1/1980 - 8/31/2000	1117.926	1306.776
10/1/1980 - 9/29/2000	1086.826	1245.506
11/1/1980 - 10/31/2000	1039.486	1187.219
12/1/1980 - 11/30/2000	982.612	1089.670
1/1/1981 - 12/29/2000	1003.640	1123.743
2/1/1981 - 1/31/2001	1033.224	1168.478
3/1/1981 - 2/28/2001	1008.651	1115.371
4/1/1981 - 3/30/2001	957.566	1036.827
5/1/1981 - 4/30/2001	1002.152	1094.713
6/1/1981 - 5/31/2001	987.791	1085.730
...	...	...
11/1/1996 - 10/31/2016	352.541	369.599
12/1/1996 - 11/30/2016	339.889	357.555
1/1/1997 - 12/30/2016	354.238	372.874
2/1/1997 - 1/31/2017	353.041	370.959
3/1/1997 - 2/28/2017	370.692	389.793
4/1/1997 - 3/31/2017	377.634	399.327
5/1/1997 - 4/28/2017	359.004	380.183
6/1/1997 - 5/31/2017	345.191	362.218
7/1/1997 - 6/30/2017	334.665	349.466
8/1/1997 - 7/31/2017	319.866	333.847
9/1/1997 - 8/31/2017	333.487	349.898
10/1/1997 - 9/29/2017	330.701	345.976
11/1/1997 - 10/31/2017	342.191	364.504
12/1/1997 - 11/30/2017	340.144	363.304
1/1/1998 - 12/29/2017	344.474	366.396

```
2/1/1998 - 1/31/2018            348.007          374.251
3/1/1998 - 2/28/2018            338.640          356.169
4/1/1998 - 3/30/2018            325.527          338.153
5/1/1998 - 4/30/2018            312.560          326.894
6/1/1998 - 5/31/2018            314.979          332.018
7/1/1998 - 6/29/2018            307.895          323.611
8/1/1998 - 7/31/2018            309.629          329.146
9/1/1998 - 8/31/2018            339.274          373.647
10/1/1998 - 9/28/2018           333.187          366.208
11/1/1998 - 10/31/2018          309.048          329.762
12/1/1998 - 11/30/2018          301.277          319.184
1/1/1999 - 12/31/2018           288.027          294.661
2/1/1999 - 1/31/2019            297.618          307.448
3/1/1999 - 2/28/2019            320.408          333.564
4/1/1999 - 3/29/2019            314.725          325.092

[244 rows x 9 columns]
```

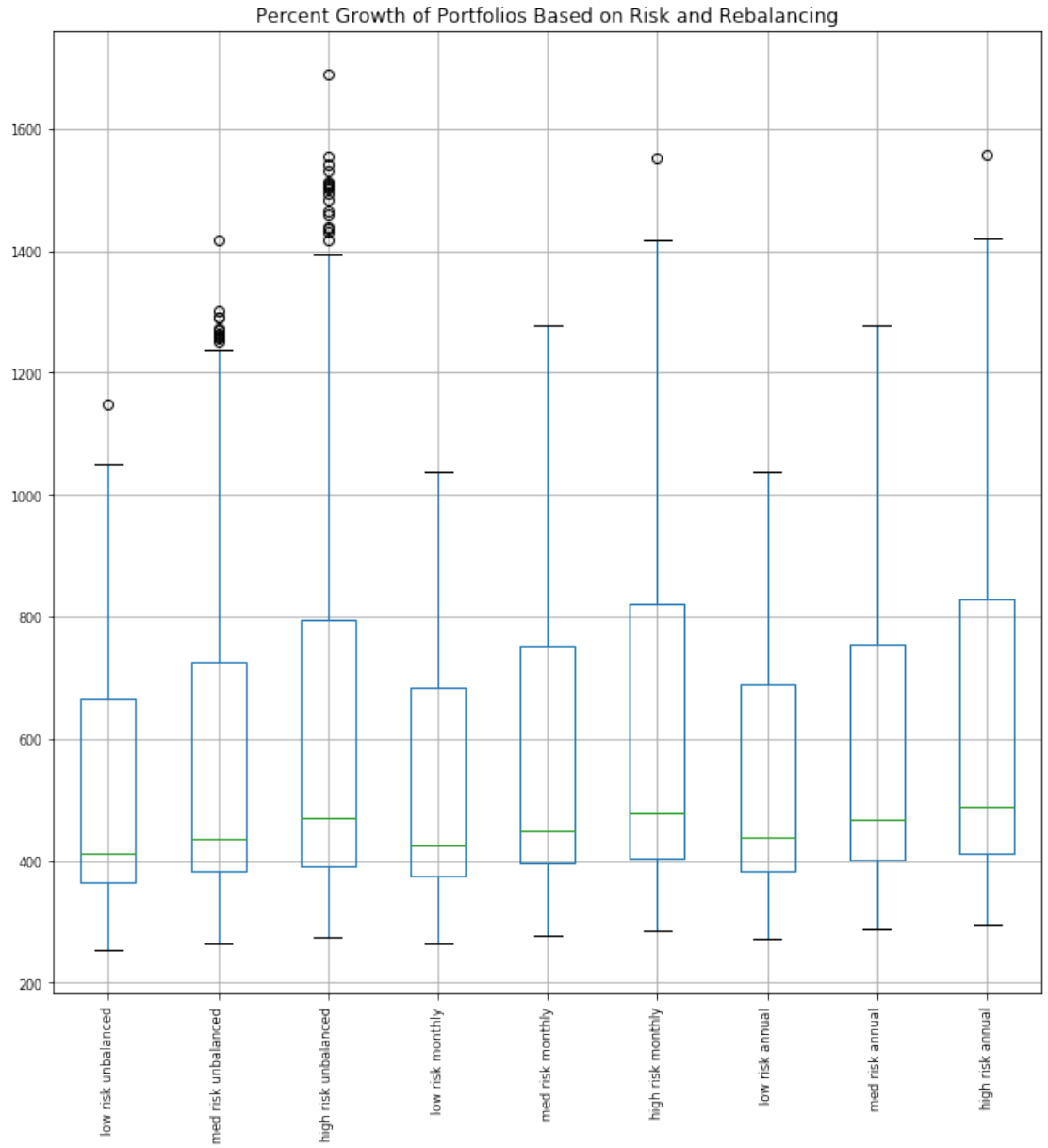
```
In [41]: df.plot.hist(subplots=True, rot=90, figsize=(8,12), sharey=True, title="Frequency of
```

```
Out[41]: array([<matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9c5cd68>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9ca1860>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9bef898>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9c14b70>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9bbae48>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9bea160>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9b90438>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9b37748>,
                <matplotlib.axes._subplots.AxesSubplot object at 0x7fcae9b37780>],
               dtype=object)
```


Frequency of Percent Growth Based on Risk and Rebalancing
low risk unbalanced
med risk unbalanced
high risk unbalanced
low risk monthly
med risk monthly
high risk monthly
low risk annual
med risk annual
high risk annual
Frequency
0
50
100
200
400
600
800
1000
1200
1400
1600

In [42]:
```
df.plot.box(rot=90, fontsize=8, title='Percent Growth of Portfolios Based on Risk and
```

Out[42]: <matplotlib.axes._subplots.AxesSubplot at 0x7fcae9ee6ba8>

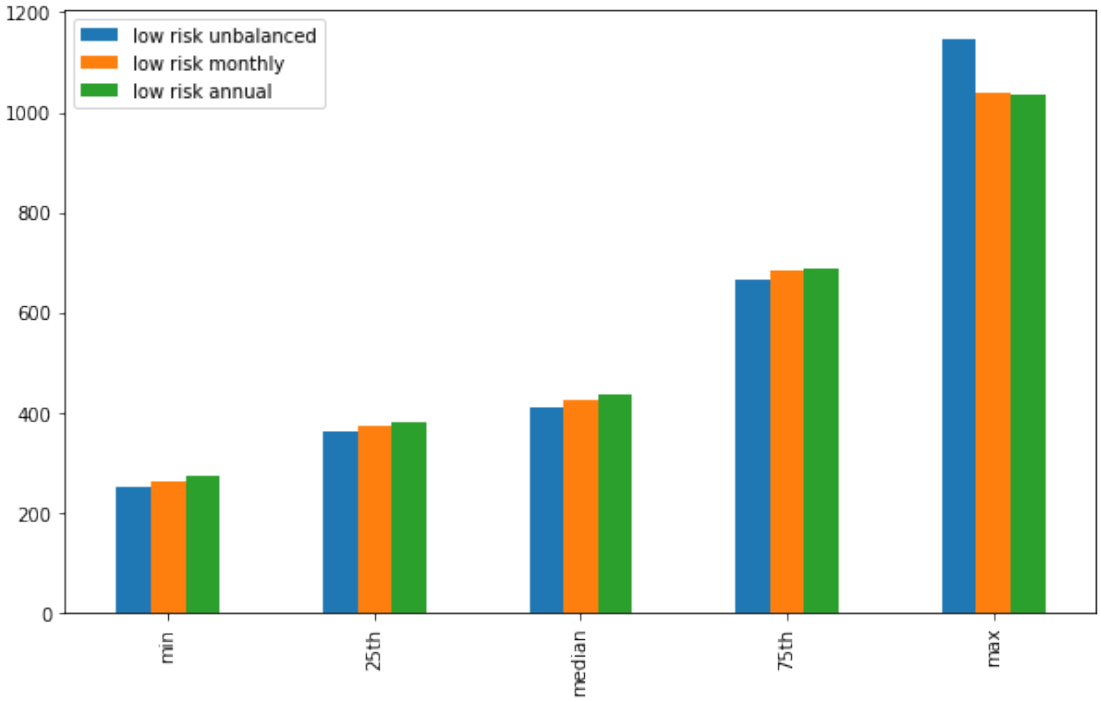


In [43]:
```
#segment portfolios based on risk
dfl = df[["low risk unbalanced", "low risk monthly", "low risk annual"]].copy()
dfm = df[["med risk unbalanced", "med risk monthly", "med risk annual"]].copy()
dfh = df[["high risk unbalanced", "high risk monthly", "high risk annual"]].copy()
```

In [54]:
```
##low risk portfolio
dfl_quantiles = pd.DataFrame([dfl.min(), dfl.quantile(.25), dfl.quantile(.5), dfl.quar
dfl_quantiles.plot.bar(figsize=(10,6))
dfl_avg = pd.DataFrame([dfl.mean(), dfl.std()], index=['mean', 'standard deviation'])
dfl_avg
```

Out[54]:

	low risk unbalanced	low risk monthly	low risk annual
mean	528.636643	528.581123	533.990332
standard deviation	232.485916	211.752877	210.025350

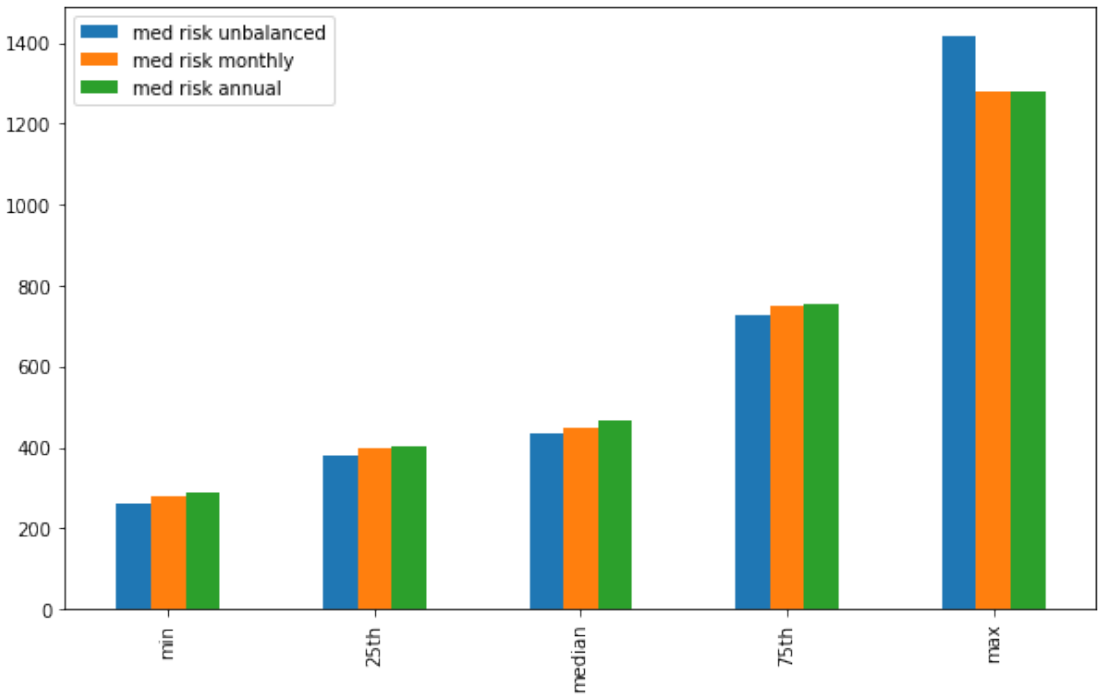


In [45]:
```
#dfl.plot.box()
```

In [56]:
```
##med risk portfolio
dfm_quantiles = pd.DataFrame([dfm.min(), dfm.quantile(.25), dfm.quantile(.5), dfm.quar
dfm_quantiles.plot.bar(figsize=(10,6))
dfm_avg = pd.DataFrame([dfm.mean(), dfm.std()], index=['mean', 'standard deviation'])
dfm_avg
```

Out[56]:

	med risk unbalanced	med risk monthly	med risk annual
mean	585.873172	586.561115	593.749484
standard deviation	288.599406	259.290299	257.082143

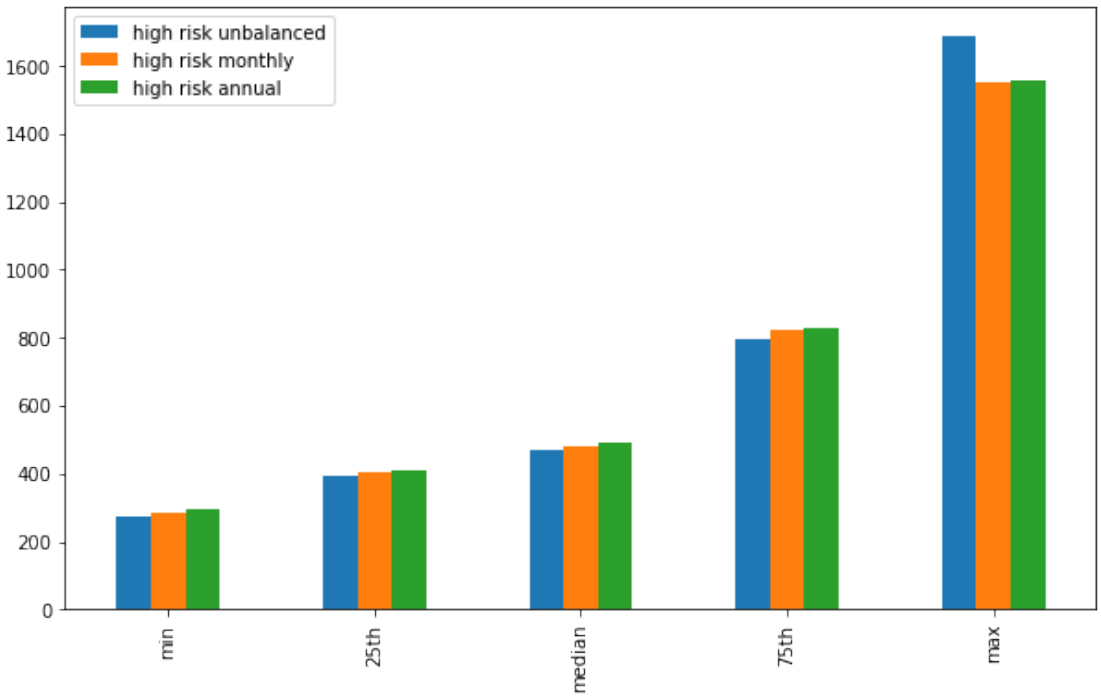


In [47]:
```
#dfm.plot.box()
```

In [57]:
```
##annually rebalanced portfolio
dfh_quantiles = pd.DataFrame([dfh.min(), dfh.quantile(.25), dfh.quantile(.5), dfh.quar
dfh_quantiles.plot.bar(figsize=(10,6))
dfh_avg = pd.DataFrame([dfh.mean(), dfh.std()], index=['mean', 'standard deviation'])
dfh_avg
```

Out[57]:

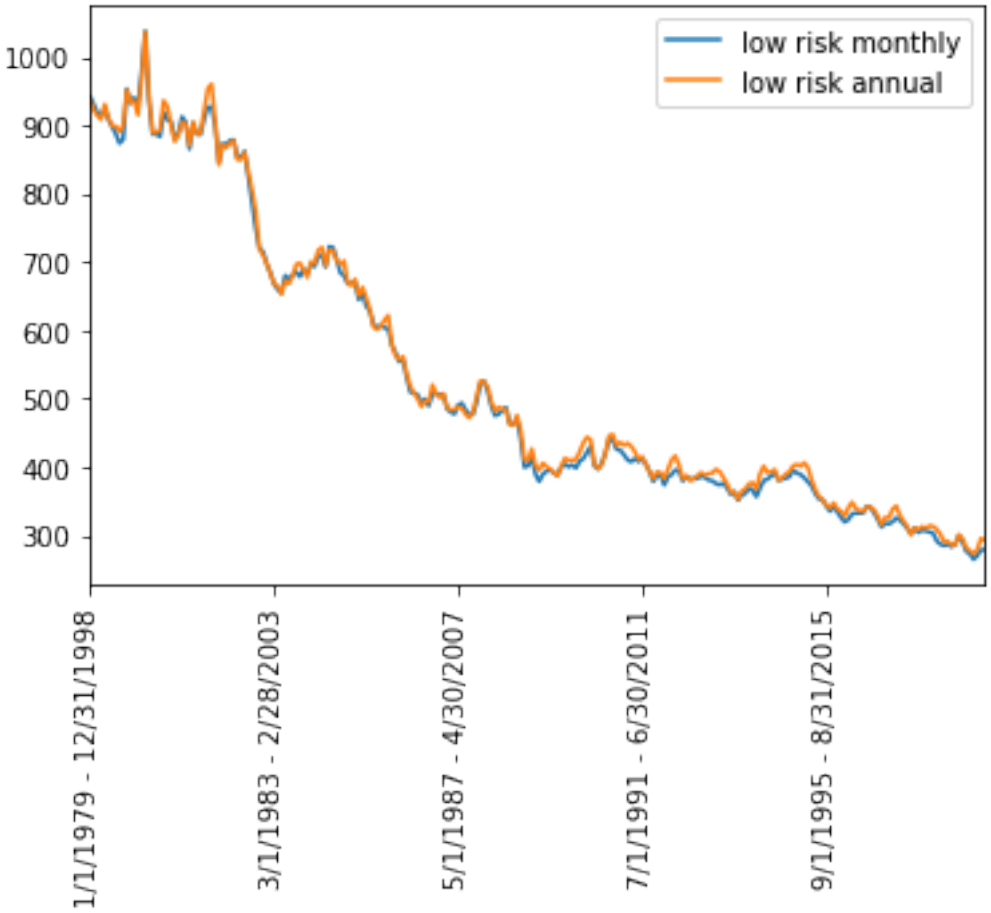
	high risk unbalanced	high risk monthly	high risk annual
mean	643.109725	641.506455	648.460889
standard deviation	346.688607	314.795636	313.532269

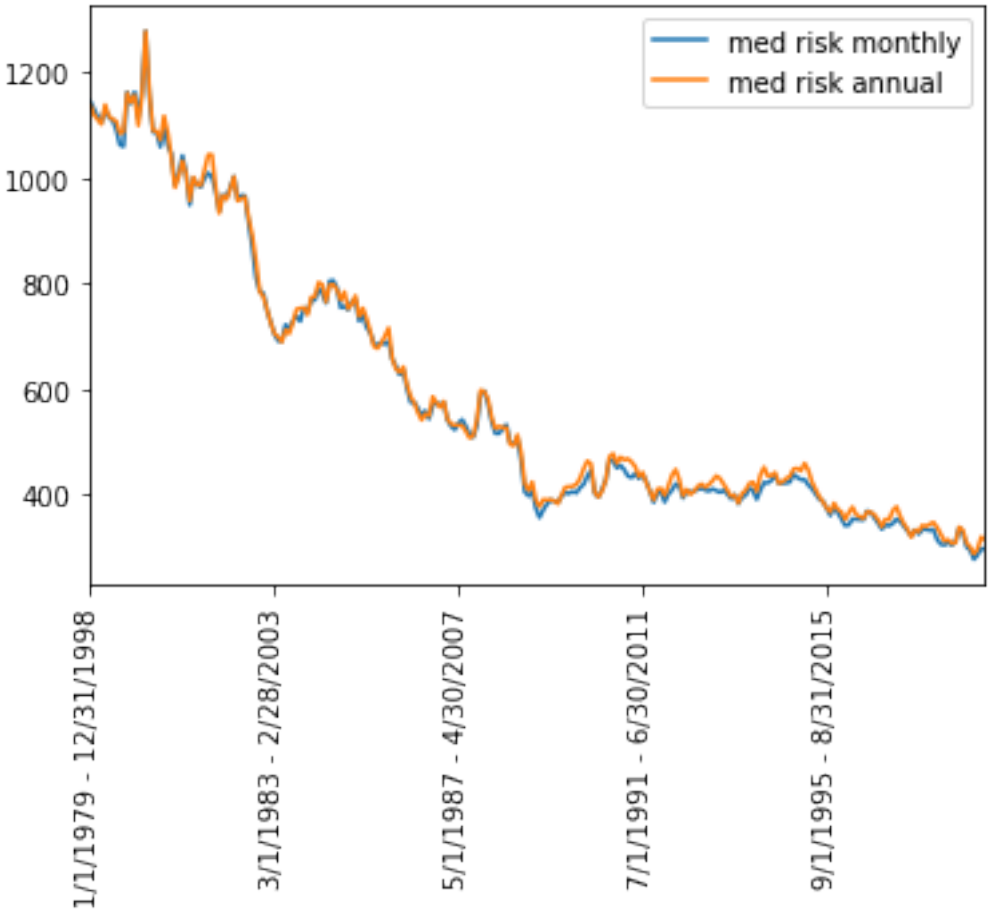


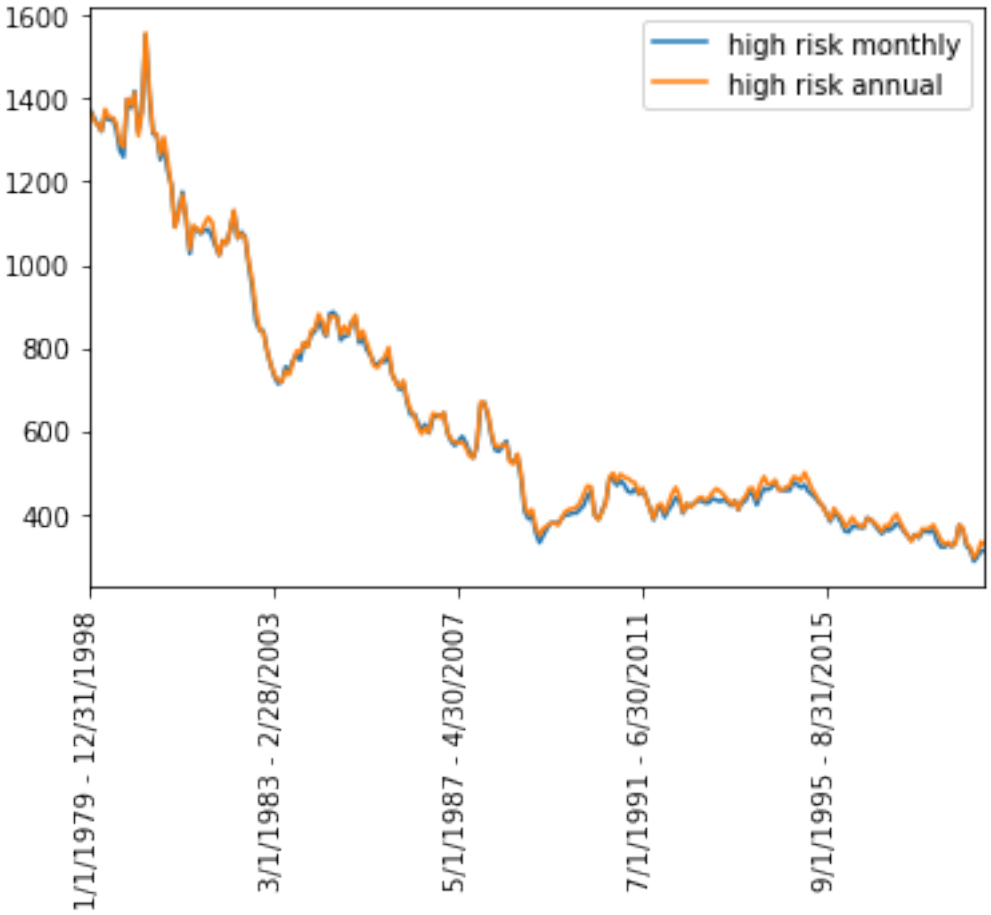

```
In [49]: #dfh.plot.box()

In [50]: #show correlation between rebalancing timeframes
         dfl[['low risk monthly', 'low risk annual']].plot(rot=90)
         dfm[['med risk monthly', 'med risk annual']].plot(rot=90)
         dfh[['high risk monthly', 'high risk annual']].plot(rot=90)

Out[50]: <matplotlib.axes._subplots.AxesSubplot at 0x7fcae94d9550>
```


low risk monthly
low risk annual
1000
900
800
700
600
500
400
300
1/1/1979 - 12/31/1998
3/1/1983 - 2/28/2003
5/1/1987 - 4/30/2007
7/1/1991 - 6/30/2011
9/1/1995 - 8/31/2015


med risk monthly
med risk annual
1200
1000
800
600
400
1/1/1979 - 12/31/1998
3/1/1983 - 2/28/2003
5/1/1987 - 4/30/2007
7/1/1991 - 6/30/2011
9/1/1995 - 8/31/2015


high risk monthly
high risk annual
1600
1400
1200
1000
800
600
400
1/1/1979 - 12/31/1998
3/1/1983 - 2/28/2003
5/1/1987 - 4/30/2007
7/1/1991 - 6/30/2011
9/1/1995 - 8/31/2015