In [1]:

```
import pandas as pd
import numpy as np
import math
import seaborn as sns
import scipy.stats
```

Loading data

In [38]:

```
predictor_data = pd.read_excel("Downloads/PredictorData (1).xls")
predictor_data.head()
```

Out[38]:

	yyyyq	Index	D3	D12	E3	E12	b/m	tbl	AAA	BAA	...	SP12	Unnamed: 31	Num	Benchmark_Sum	Benchmark_Premiu
0	18711	4.61	NaN	0.26	NaN	0.4000	NaN	NaN	NaN	NaN	...	0.030781	NaN	NaN	NaN	Na
1	18712	4.82	NaN	0.26	NaN	0.4000	NaN	NaN	NaN	NaN	...	0.035396	NaN	NaN	NaN	Na
2	18713	4.84	NaN	0.26	NaN	0.4000	NaN	NaN	NaN	NaN	...	0.035845	NaN	NaN	NaN	Na
3	18714	4.74	NaN	0.26	NaN	0.4000	NaN	NaN	NaN	NaN	...	0.000115	NaN	NaN	NaN	Na
4	18721	5.04	NaN	0.27	NaN	0.4075	NaN	NaN	NaN	NaN	...	0.011372	NaN	NaN	NaN	Na

5 rows × 40 columns

In [3]:

```
predictor_data.shape
```

Out[3]:

```
(540, 40)
```

Gather the Data needed

In [12]:

```
data = predictor_data[['yyyyq','Index','E3','Rfree','ik']].copy()
data['SP3'] = data.E3/data.Index - data.Rfree
data = data.dropna().reset_index(drop = True)
data['Premium_Sum'] = 0.0
data['Benchmark_Prediction'] = 0.0
data['Predictor_1'] = 0.0
data['Predictor_2'] = 0.0
data['Predictor_3'] = 0.0
data['Predictor_4'] = 0.0
data['Predictor_5'] = 0.0
data['Predictor_6'] = 0.0
data['Predictor_7'] = 0.0
data['Predictor_8'] = 0.0
data['Predictor_9'] = 0.0
data['Predictor_10'] = 0.0
data['Predictor_11'] = 0.0
data['Predictor_12'] = 0.0
data['Predictor_13'] = 0.0
data['Predictor_14'] = 0.0
data['Predictor_15'] = 0.0
data.head()
#print(data['SP3'].dtype)
#print(data['Premium_Sum'].dtype)
```

Out[12]:

	yyyyq	Index	E3	Rfree	ik	SP3	Premium_Sum	Benchmark_Prediction	Predictor_1	Predictor_2	...	Predictor_6	I
0	19471	15.17	0.40	0.000950	0.036043	0.025418	0.0	0.0	0.0	0.0	...	0.0	
1	19472	15.21	0.38	0.000950	0.035089	0.024034	0.0	0.0	0.0	0.0	...	0.0	
2	19473	15.11	0.37	0.001841	0.034053	0.022646	0.0	0.0	0.0	0.0	...	0.0	
3	19474	15.30	0.46	0.002266	0.034825	0.027800	0.0	0.0	0.0	0.0	...	0.0	
4	19481	15.08	0.50	0.002474	0.036635	0.030683	0.0	0.0	0.0	0.0	...	0.0	

5 rows × 23 columns

Calculating CSPE for Benchmark & 15 Individual Predictors

Benchmark

Find Benchmark Predictions

In [13]:

```
i = 0
j = 1.0
data['Premium_Sum'][0] = data['SP3'][0]
while i<234:
    data['Premium_Sum'][i+1] = data['SP3'][i+1] + data['Premium_Sum'][i]
    data['Benchmark_Prediction'][i+1] = data['Premium_Sum'][i]/j
    i += 1
    j += 1.0
data.head()
```

```
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:3:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing imports until
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:5:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:6:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

Out[13]:

	yyyyq	Index	E3	Rfree	ik	SP3	Premium_Sum	Benchmark_Prediction	Predictor_1	Predictor_2	...	Predictor_6	I
0	19471	15.17	0.40	0.000950	0.036043	0.025418	0.025418	0.000000	0.0	0.0	...	0.0	
1	19472	15.21	0.38	0.000950	0.035089	0.024034	0.049452	0.025418	0.0	0.0	...	0.0	
2	19473	15.11	0.37	0.001841	0.034053	0.022646	0.072098	0.024726	0.0	0.0	...	0.0	
3	19474	15.30	0.46	0.002266	0.034825	0.027800	0.099897	0.024033	0.0	0.0	...	0.0	
4	19481	15.08	0.50	0.002474	0.036635	0.030683	0.130580	0.024974	0.0	0.0	...	0.0	

5 rows × 23 columns

Predictor

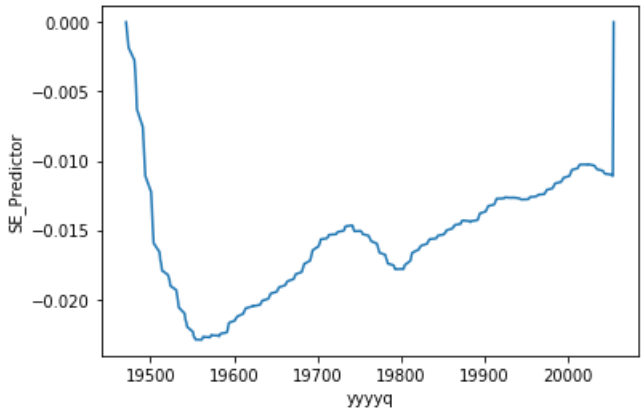
In [37]:

```
i = 1
data['SE_Predictor'] = 0.0
data['SE_Predictor'][0] = np.square(data['SP3'][0] - data['Benchmark_Prediction'][0]) - np.square(d
ata['SP3'][0] - data['Predictor_1'][0])
while i < 235:
    data['SE_Predictor'][i] = np.square(data['SP3'][i] - data['Benchmark_Prediction'][i]) - np.squa
re(data['SP3'][i] - data['Predictor_1'][i]) + data['SE_Predictor'][i-1]
    i += 1
data
ax = sns.lineplot(x='yyyyq', y="SE_Predictor", data= data)
```

```
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:3:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  This is separate from the ipykernel package so we can avoid doing imports until
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:5:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  """
```



In [31]:

```
r_hat = np.array(['Predictor_1',
'Predictor_2','Predictor_3','Predictor_4','Predictor_5','Predictor_6','Predictor_7','Predictor_8',
'Predictor_9','Predictor_10','Predictor_11','Predictor_12','Predictor_13','Predictor_14','Predictor
_15'])
n = 0
while n<15:
    i = 1
    data['SE_Predictor'] = 0.0
    data['SE_Predictor'][0] = np.square(data['SP3'][0] - data['Benchmark_Prediction'][0]) - np.squa
re(data['SP3'][0] - data[r_hat[n]][0])
    while i < 235:
        data['SE_Predictor'][i] = np.square(data['SP3'][i] - data['Benchmark_Prediction'][i]) - np.
square(data['SP3'][i] - data[r_hat[n]][i]) + data['SE_Predictor'][i-1]
        i += 1
    ax = sns.lineplot(x='yyyyq', y="SE_Predictor", data= data)
    n += 1
```

```
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:6:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

```
/Users/qinxinhan/opt/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:8:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

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```

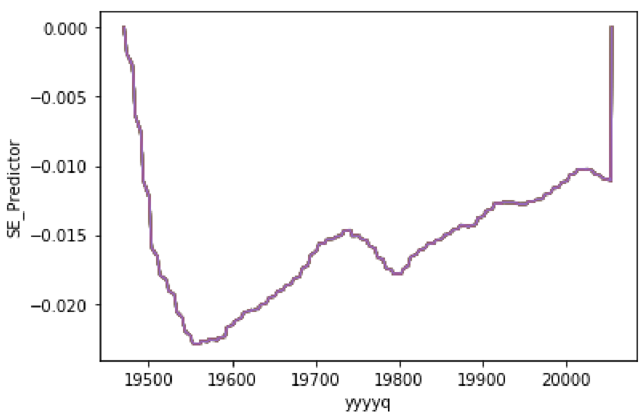

Figure 1

This figure is drawn by data in excel

In [39]:

```
ax = sns.lineplot(x='yyyyq', y='BSE_SP3SE_Dif', data= predictor_data)
```

```
# change the x and y to different sizes
```