HKGB Yield Curve Modeling

Portfolio Project by Raynard Arisgraha

In this project, I would like to analyse the different maturities of Hong Kong Government Bonds and apply two different models, Nelson-Siegel (NS) and Cubic Spline, to see how the models differ in terms of fit and interpretation.

```
# Import the relevant libraries and functions

!pip install nelson-siegel-svensson
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.interpolate import CubicSpline
import numpy as np
from nelson_siegel_svensson.calibrate import calibrate_ns_ols

sns.set()
```

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Requirement already satisfied: nelson-siegel-svensson in /usr/local/lib/python3.11/dist-packages (0.5.0)
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Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.11/dist-packages (from python-dateutil>=2.7->matplotlib>=3.5->nelson-s
```

```
# Connect to the dataset stored in the google drive

from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
# Import and clean the data to be in an indexed dataframe format

column_names = ['Date', '2 Year', '3 Year', '5 Year', '10 Year', '15 Year', '20 Year']
hkgbyields = pd.read_csv("/content/drive/MyDrive/Colab Notebooks/HKGB Benchmark Yield.csv")

hkgbyields.columns = column_names

hkgbyields["Datetime"] = pd.to_datetime(hkgbyields["Date"], format="%d.%m.%y")
hkgbyields.set_index("Datetime", inplace=True)
hkgbyields.drop('Date', axis=1, inplace=True)

hkgbyields = hkgbyields.dropna()

hkgbyields.head()
```

	2 Year	3 Year	5 Year	10 Year	15 Year	20 Year
Datetime						
2009-09-03	0.559	-	-	-	-	-
2009-09-04	0.588	-	-	-	-	-
2009-09-07	0.588	-	-	-	-	-
2009-09-08	0.587	-	-	-	-	-
2009-09-09	0.587	-	-	-	-	-

```
# Calculate and store the standard deviation and means of the different maturities
```

```
hkgbyields = hkgbyields.apply(pd.to_numeric,errors='coerce')
y_std = hkgbyields.std()
y_mean = hkgbyields.mean()
```

```
                 0
2 Year    0.394161
3 Year    1.367670
5 Year    1.538864
10 Year   2.006853
15 Year   2.239927
20 Year   3.930744

dtype: float64
```

```
# Making a plot of the data and showing specifically the yields on

def plot_yield_curve(date):
    maturities = ['2 Year', '3 Year', '5 Year', '10 Year', '15 Year', '20 Year']
    fig, ax = plt.subplots(figsize=(12, 6))
    ax.plot(maturities, hkgbyields.loc[date], marker='D', label='Yield Curve at ' + date)

    ax.set_yticklabels(['{:.2f}%'.format(y) for y in ax.get_yticks()])
    ax.set_xticks(range(len(maturities)))
    ax.set_xticklabels(maturities)

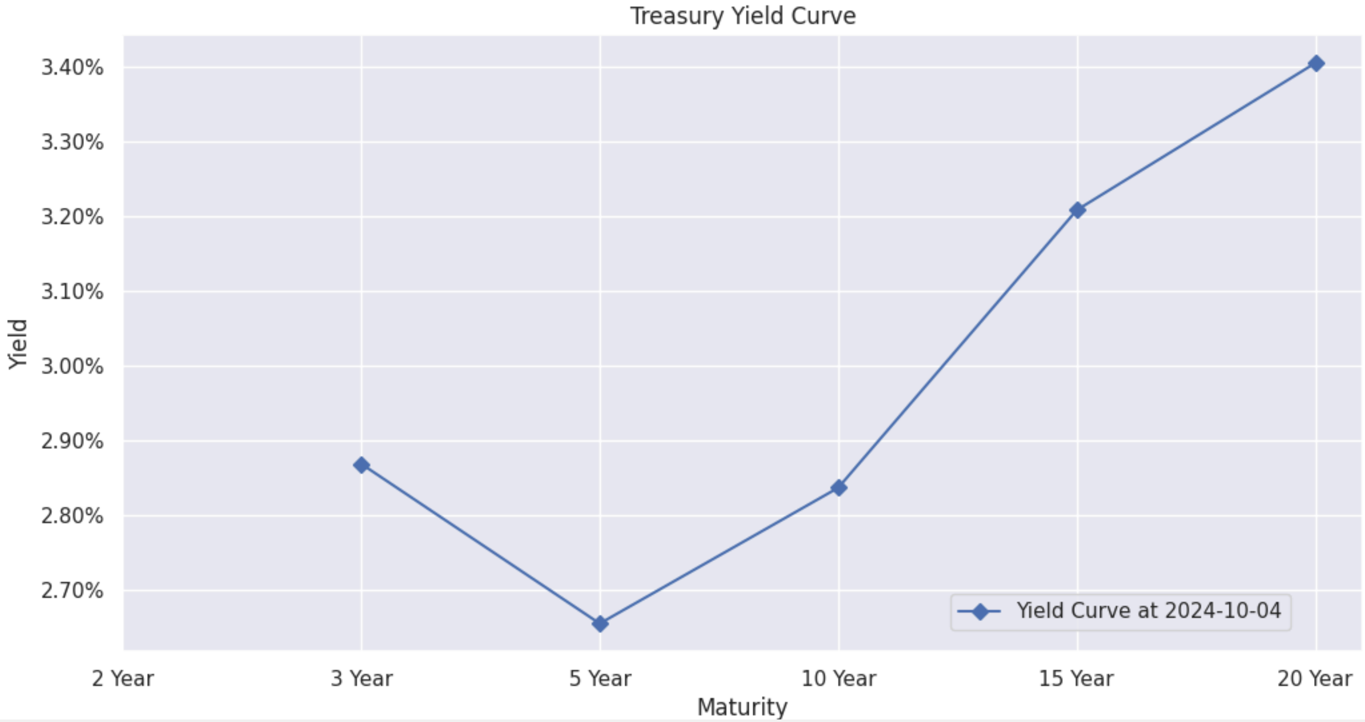
    # Add labels and title
    ax.set_xlabel('Maturity')
    ax.set_ylabel('Yield')
    ax.set_title('Treasury Yield Curve')


    fig.legend(loc = [0.69, 0.14])

    # Show the plot
    plt.grid(True)
    plt.show()

print("Hong Kong Government Bonds Treasury Yield Curve")
plot_yield_curve('2024-10-04')
```

```
Hong Kong Government Bonds Treasury Yield Curve
<ipython-input-15-96bc5c93faeb>:8: UserWarning: set_ticklabels() should only be used with a fixed number of ticks, i.e. after set_ticks(
  ax.set_yticklabels(['{:.2f}%'.format(y) for y in ax.get_yticks()])
```



Plotting the Nelson Siegel Model

```
# Create maturity and yield variables in array form, dropping 2Y as unavailable on 2024-10-04

t = np.array([3,5,10,15,20])
y = np.array(hkgbyields.loc["2024-10-04"][1:])


# Fit an Nelson-Siegel (NS) model for yields from 2024-10-04

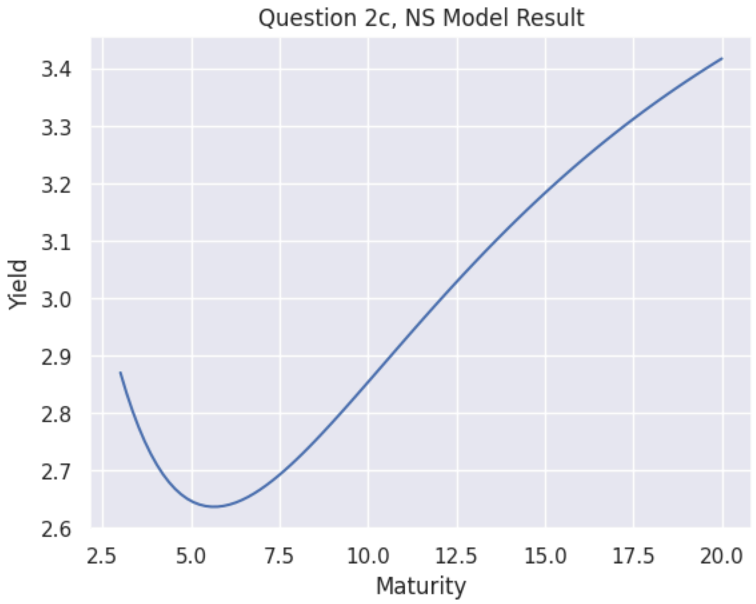
curve, status = calibrate_ns_ols(t, y, tau0=1.0)  # starting value of 1.0 for the optimization of tau
assert status.success
print(curve)
```

```
NelsonSiegelCurve(beta0=4.220543620344303, beta1=0.24162511668198272, beta2=-5.67667750841785, tau=2.986525823647642)
```

```
# Plotting the NS model result

y_hat = curve
t_hat = np.linspace(3,20,100)
plt.plot(t_hat, y_hat(t_hat))
plt.xlabel("Maturity")
plt.ylabel("Yield")
plt.title("Question 2c, NS Model Result")
```

```
Text(0.5, 1.0, 'Question 2c, NS Model Result')
```



Plotting the Cubic Spline Model

```
# Showing the yields on 2024-10-04

hkgbyields.loc["2024-10-04"]
```

	2024-10-04
2 Year	NaN
3 Year	2.868
5 Year	2.654
10 Year	2.836
15 Year	3.208
20 Year	3.405

dtype: float64

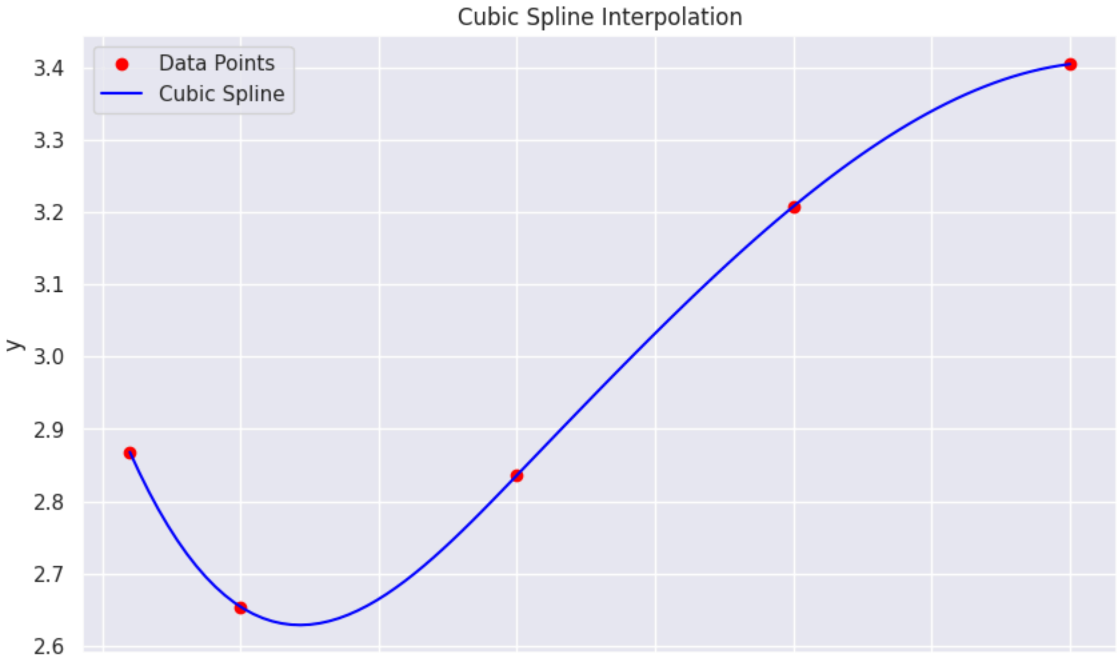
```
# Put the above yield values in array format

t = np.array([3,5,10,15,20])
y = np.array([2.868,2.654,2.836,3.208,3.405])


# Create a cubic spline interpolation object
cs = CubicSpline(t, y)

# Generate new x values for plotting
t_new = np.linspace(3, 20, 100)
y_new = cs(t_new)

# Plot the cubic spline interpolation
plt.figure(figsize=(10, 6))
plt.plot(t, y, 'o', label='Data Points', color='red')  # Original data points
plt.plot(t_new, y_new, label='Cubic Spline', color='blue')  # Spline curve
plt.title('Cubic Spline Interpolation')
plt.xlabel('t')
plt.ylabel('y')
plt.legend()
plt.grid(True)
plt.show()
```



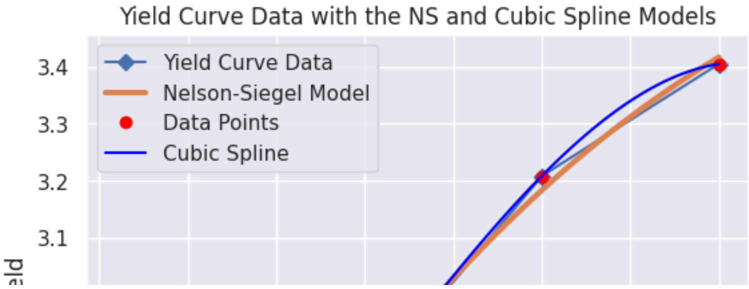
```
# Plot the yield curve data
maturities = [3,5,10,15,20]
plt.plot(maturities, y, marker='D', linestyle='-', label='Yield Curve Data')

# Add the NS model plot
y_hat = curve
t_hat = np.linspace(3,20,100)
plt.plot(t_hat, y_hat(t_hat), linewidth=3, label='Nelson-Siegel Model')

# Add the cubic spline plot

plt.plot(t, y, 'o', label='Data Points', color='red')
plt.plot(t_new, y_new, label='Cubic Spline', color='blue')

plt.xlabel("Maturity")
plt.ylabel("Yield")
plt.title("Yield Curve Data with the NS and Cubic Spline Models")
plt.legend()
plt.grid(True)
plt.show()
```


Yield Curve Data with the NS and Cubic Spline Models
Yield Curve Data
Nelson-Siegel Model
Data Points
Cubic Spline
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