Yield To Maturity Curve

February 5, 2020

1 Finding yield curves for government security bonds

[1]:
```
#Importing Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import datetime
```

[2]:
```
#Reading Interest Rate Sheet
ir = pd.read_excel("4.Interest Rates.xlsx")
ir.head()
```

[2]:
```
   Maturity (Yrs)     Rates
0             0.0  5.009979
1             0.5  5.130204
2             1.0  5.272825
3             1.5  5.426716
4             2.0  5.584212
```

[4]:
```
#Reading list of bonds sheet
bond_list = pd.read_excel("4. Bond List.xlsx")
bond_list.head()
```

[4]:
```
  SECTYPE SECURITY   ISSUE_NAME                      ISSUE_DESC ISSUE_DATE  \
0      TB     182D  190320.0000      GOI T BILL 182D-19/03/2020 2019-09-19
1      GS   CG2024       0.0915             GOI LOAN 9.15% 2024 2011-11-14
2      GS   CG2025       0.0772             GOI LOAN 7.72% 2025 2015-05-25
3      GS   CG2027       0.0824  GOI LOAN 8.24%2027(NATBK.RECAP 2007-02-15

    MAT_DATE Last IP Dt Next IP Dt     Cpn Freq Last Traded Date  \
0 2020-03-19        NaT        NaT          NaN       2020-01-22
1 2024-11-14 2019-11-14 2020-05-14  Half Yearly       2020-01-30
2 2025-05-25 2019-11-25 2020-05-25  Half Yearly       2020-01-28
3 2027-02-15 2019-08-15 2020-02-15  Half Yearly       2020-01-24

   Last Traded Price (in Rs.)      ISIN NO.
0                     99.2266  IN002019Y266
```

```
1                    110.4802   IN0020110048
2                    104.9500   IN0020150036
3                    107.7200   IN0020060078
```

[5]:
```
today_date = datetime.datetime(2019,12,9)
today_date
```

[5]: datetime.datetime(2019, 12, 9, 0, 0)

[6]:
```
dirty_price = []
accrued_int = []
quoted_price = []
time_to_maturity = []
ytm = []
```

[7]:
```
    #Treasury Bills

    #Input values
    FV = 100
    N = (bond_list.iloc[0,5] - today_date).days/365
    time_to_maturity.append((bond_list.iloc[0,5] - today_date).days/(365))
    w = 2*N -int(2*N)

    #Current value of bond
    rr = (ir.iloc[int(N*2),1] + (w)*(ir.iloc[int(N*2)+1,1]-ir.
 ↪iloc[int(N*2),1]))/100
    val = FV/((1+rr)**(N))
    dirty_price.append(val)
    accrued = (1-w)*FV
    accrued_int.append(accrued)
    quoted = val - accrued
    quoted_price.append(quoted)

    #Finding YTM

    y = rr
    ytm.append(y)
```

[8]:
```
# Iterative reading of government security that pay coupons

for i in range(1,len(bond_list)):

    #Input values
    FV = 100
    Cpn_Rate = bond_list.iloc[i,2]
    f=2
    N = int((bond_list.iloc[i,5] - today_date).days/(365/f))+1
```

```
    NoDaysTillNextCpn = (bond_list.iloc[i,7] - today_date).days
    w=(NoDaysTillNextCpn/(365/f))
    tol = 0.0001
    time_to_maturity.append((bond_list.iloc[i,5] - today_date).days/(365))

    #Current value of bond
    j=1
    val = 0
    while(j<=N):
        rr = (ir.iloc[j-1,1] + w*(ir.iloc[j,1]-ir.iloc[j-1,1]))/100
        val = val + (Cpn_Rate*FV)/f/((1+rr/f)**(j-1+w))
        j=j+1
    val = val + FV/((1+rr/f)**(N-1+w))
    dirty_price.append(val)
    accrued = (1-w)*Cpn_Rate*FV/f
    accrued_int.append(accrued)
    quoted = val - accrued
    quoted_price.append(quoted)

    #Finding YTM

    y = ir.iloc[:N,1].mean()  #Initialising y
    y = y/100

    while(True):
        v1 = 0
        v2 = 0
        k=1
        while(k<=N):
            v = (Cpn_Rate*FV)/f/((1+y/f)**(k-1+w))
            v1 = v1 + v
            v2 = v2 + v*((k-1+w)/f)/(1+y/f)
            k=k+1
        v1 = v1 + FV/((1+y/f)**(N-1+w))
        v2 = v2 + FV*((N-1+w)/f)/((1+y/f)**(N+w))

        if(abs(val - v1) < tol):   #Setting tolerance level
            break
        else:
            y = y - (val-v1)/v2

    ytm.append(y)
```

[9]:
```
time_to_maturity
```

[9]: [0.27671232876712326, 4.936986301369863, 5.463013698630137, 7.191780821917808]

[10]:
```
ytm
```

[10]:
```
[0.05076514068980115,
 0.06292903176237162,
 0.06400547405647529,
 0.06634319211847722]
```

[11]:
```
dirty_price
```

[11]:
```
[98.63910423877688, 112.58149811124203, 106.3027467986863, 111.63028003468983]
```

[12]:
```
accrued_int
```

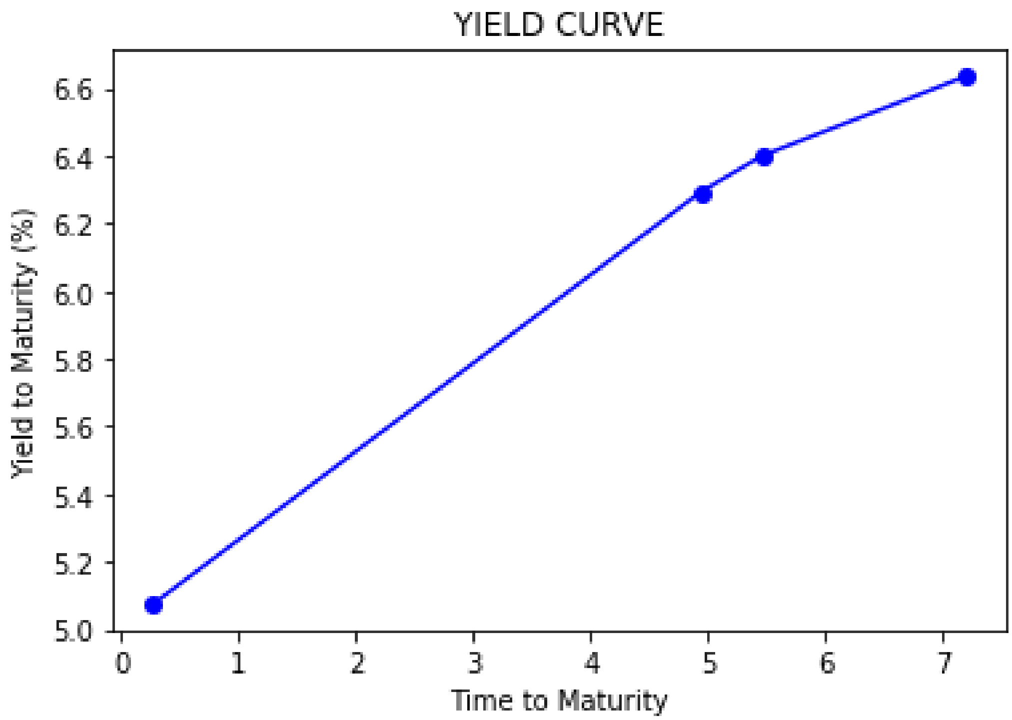
[12]:
```
[44.657534246575345,
 0.6392465753424657,
 0.30668493150684933,
 2.584876712328767]
```

[13]:
```
quoted_price
```

[13]:
```
[53.981569992201536,
 111.94225153589956,
 105.99606186717945,
 109.04540332236107]
```

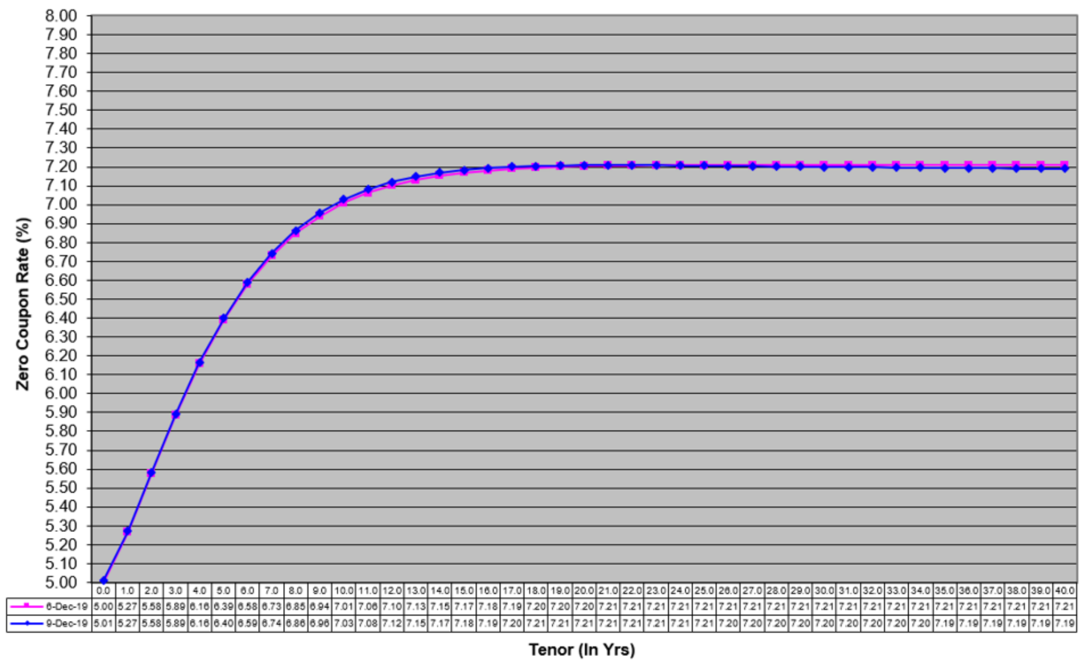
[21]:
```
#Plotting the yield curve
plt.plot(time_to_maturity, [i*100 for i in ytm], color='blue',marker='o')
plt.xlabel("Time to Maturity")
plt.ylabel("Yield to Maturity (%)")
plt.title("YIELD CURVE")
```

[21]:
```
Text(0.5,1,'YIELD CURVE')
```



[18]:
```python
#This is the ZCYC yield curve as downloaded from the NSE website
from IPython.display import Image
Image(filename='ZCYC Yield Curve.png')
```

[18]:



Critical comments

As can be seen, the graph so obtained by me for the yield curve closely resembles the ZCYC curve. Clearly, the lack of data points results in a not-so-smooth yield curve, however the essence remains the same. As time to maturity increases, yield to maturity also increases though in a decreasing fashion.

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[ ]:
```