Executive Education | POST GRADUATION

DATA SCIENCE FOR FINANCE

Fixed Income Securities

2023/2024

Individual Project

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1. Introduction

Challenges and Strategies in Managing Swap Contracts

The dynamics of the global financial market demand a strategic and discerning approach to asset and liability management. Swap contracts, fundamental instruments in hedge strategies, provide flexibility and opportunities but also present intricate challenges. In this report, we delve into a comprehensive analysis of a swap contract, employing a range of metrics including yield curve construction, calculation of present values for fixed and floating legs, and risk assessment.

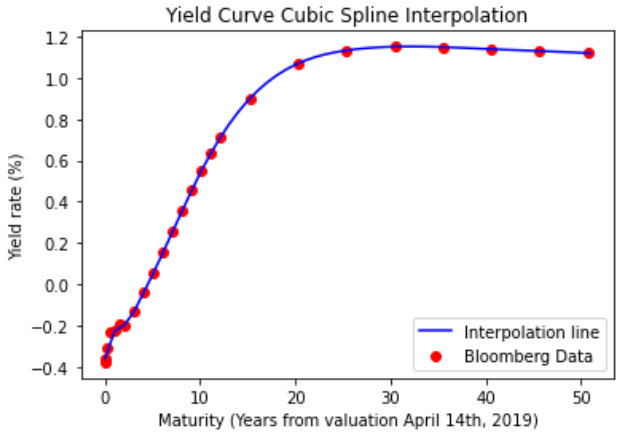
Understanding the market value of the swap contract, represented by a net depreciation, underscores the need for a critical evaluation of fixed and floating interest rates. The presence of an unfavorable Net Present Value (NPV) raises questions about the efficacy of one contract structure. Amidst these considerations, the analysis of interest rate risk through metrics such as PV01, DV01, and Gamma could highlight the contract's sensitivity to interest rate fluctuations.

As we explore diagnoses and recommendations, there emerges a necessity for a comprehensive strategic review. The pursuit of a more robust hedge strategy, tailored to current market conditions, becomes imperative. Additionally, the introduction of continuous monitoring systems and the consideration of future scenarios are crucial for portfolio adaptability in a dynamic financial environment.

2. Yield Curve Construction using Cubic Spline Interpolation

a) Build the complete yield curve using interpolation techniques.

The yield curve has been constructed using Cubic Spline interpolation techniques. This mathematical approach allows us to estimate interest rates at various maturities, providing a comprehensive view of the interest rate environment.



The yield curve exhibits a positive slope, suggesting a trend of increasing interest rates as the maturity term extends. Cubic spline interpolation enables the filling of gaps between known data points, providing a smooth and continuous representation of the curve.

3. Accrued Interest Calculation

b) Compute the accrued interest in the fixed and floating legs of the contract.

Accrued interest has been computed for both the fixed and floating legs of the contract. With a T+0 settlement lag assumption, the fixed leg accrued interest is €1395.80 (0.013958%) and the floating leg accrued interest is -€5506.67 (-0.055067%). These values reflect the interest earned but not yet received as of the trade date.

To implement some accrued in this project The Python library "QuantLib" (https://quantlib-python-docs.readthedocs.io/en/latest/index.html) was used to calculate of fixed and floating leg and others steps such as temporal series and dates diff values.

Set the assumptions

```
[23]
settlement_date = ql.Date(15, 4, 2019)
issue_date = ql.Date(19,1, 2007)
maturity_date = ql.Date(19, 1, 2032)
notional_value = 10e6
swap_rate = fixed_rate = 0.05982 / 100
```

Fixed the leg:

```
[24]
...  Fixed Leg AI: 1395.8000000000002€
     Fixed Leg AI: 0.013958000000000002%
```

Code in Python representing all calculation steps cis presented in official jupyter notebook as support documentation to this project

Floating leg:

```
[25]
...  Floating Leg AI: -5506.666666666666€
     Floating Leg AI: -0.05506666666666667%
```

4. Market Value of the Swap Contract

c) Calculate the clean (principal) and dirty market value of the swap contract.

The market values provide insights into the principal and accrued interest for both legs of the swap, indicating the current financial position of the contract.

Fixed leg	**Floating leg**
Present Value: €9,204,072.20	Floating Leg PV: €10,786,251.26
Clean Price: 92.0407	Clean Price: 107.8625
Dirty Price: 92.0547	Dirty Price: 107.8074

Swap Contract Value: -€1,582,179.06

5. Net Present Value (NPV) of the Contract

d) Estimate the net present value of the contract

Fixed Leg NPV: €9,202,676.40

Floating Leg NPV: €10,791,757.92

Net Present Value (NPV) of the Contract: -€1,589,081.52

This assessment reveals the net impact of the fixed and floating legs, showing the overall present value of the contract.

6. Swap Par Rate

e) Estimate the swap par rate.

The swap par rate, set at 1.3294%, is the fixed interest rate that balances the present value of both legs of the swap contract, contributing to fair valuation.

```
from scipy.optimize import fsolve

def find_swap_par_rate(fixed_rate):
    return sum(get_fixed_leg_payments(fixed_rate)) - floating_leg_pv
```

Python library used in this step:
https://docs.scipy.org/doc/scipy/reference/optimize.html#module-scipy.optimize

7. Interest Rate Risk Analysis

f) Estimate the following IRS Greeks: present value of a one basis point shift (PV01), DV01, Gamma and discuss the interest rate risk of the contract.

PV01 (Present Value of a One Basis Point Shift): €14,222.50

DV01 (Dollar Value of 1 Basis Point Shift): €142,224,983,850.48

Gamma: €137,994.75

Interest rate risk is a critical consideration. The higher PV01, DV01, and Gamma values indicate a substantial sensitivity to interest rate changes, suggesting potential impact and the need for risk management strategies.