# QF3101 HW Report

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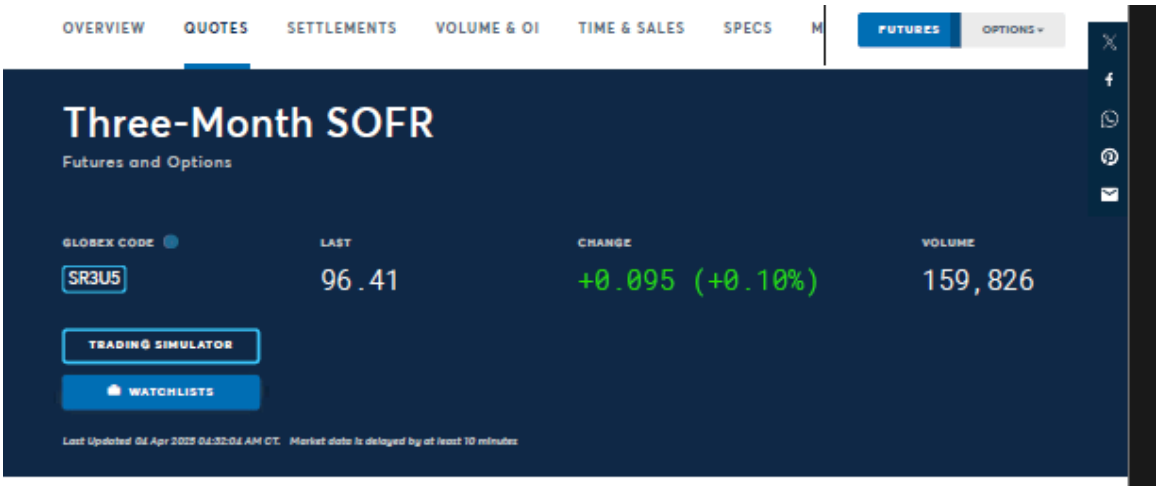
## Part 1 Stage 1

1. Business Day, X → 4th April 2025
2. Screenshot of web page




THREE-MONTH SOFR FUTURES - QUOTES

VENUE: GLOBEX

AUTO-REFRESH IS OFF Last Updated 04 Apr 2025 04:31:51 AM CT. Market data is delayed by at least 10 minutes.

| MONTH | OPTIONS | CHART | LAST | CHANGE | PRIOR SETTLE | OPEN | HIGH | LOW | VOLUME | UPDATED |
|---|---|---|---|---|---|---|---|---|---|---|
| JAN 2025 SR3F5 | OPT | | - | - | 95.645 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| FEB 2025 SR3G5 | OPT | | - | - | 95.6575 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| MAR 2025 SR3H5 | OPT | | 95.7825 | +0.0125 (+0.01%) | 95.69 | 95.6975 | 95.7875 | 95.6975 | 31,144 | 04:22:31 CT 04 Apr 2025 |
| APR 2025 SR3J5 | OPT | | 95.79 | +0.0375 (+0.04%) | 95.7525 | 95.7775 | 95.79 | 95.7775 | 11 | 03:58:16 CT 04 Apr 2025 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **JUN 2025** SR3M5 | OPT | | 96.035 | +0.065 (+0.07%) | 95.97 | 96.005 | 96.055 | 95.99 | 171,981 | 04:22:53 CT 04 Apr 2025 |
| **JUL 2025** SR3N5 | OPT | | 96.17 | +0.095 (+0.10%) | 96.075 | 96.14 | 96.17 | 96.14 | 110 | 03:35:55 CT 04 Apr 2025 |
| **AUG 2025** SR3Q5 | OPT | | - | - | 96.20 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| **SEP 2025** SR3U5 | OPT | | 96.41 | +0.095 (+0.10%) | 96.315 | 96.355 | 96.44 | 96.34 | 159,826 | 04:22:59 CT 04 Apr 2025 |
| **DEC 2025** SR3Z5 | OPT | | 96.67 | +0.105 (+0.11%) | 96.565 | 96.605 | 96.71 | 96.59 | 203,723 | 04:22:55 CT 04 Apr 2025 |
| **MAR 2026** SR3H6 | OPT | | 96.84 | +0.105 (+0.11%) | 96.735 | 96.775 | 96.875 | 96.76 | 150,621 | 04:22:55 CT 04 Apr 2025 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MAR 2026 SR3H6 | OPT | | 96.84 | +0.105 (+0.11%) | 96.735 | 96.775 | 96.875 | 96.76 | 158,621 | 04:22:55 CT 04 Apr 2025 |
| JUN 2026 SR3M6 | OPT | | 96.935 | +0.105 (+0.11%) | 96.83 | 96.865 | 96.96 | 96.85 | 153,966 | 04:22:59 CT 04 Apr 2025 |
| SEP 2026 SR3U6 | OPT | | 96.97 | +0.105 (+0.11%) | 96.865 | 96.905 | 96.995 | 96.885 | 118,888 | 04:22:55 CT 04 Apr 2025 |
| DEC 2026 SR3Z6 | OPT | | 96.965 | +0.105 (+0.11%) | 96.86 | 96.895 | 96.985 | 96.875 | 142,941 | 04:22:55 CT 04 Apr 2025 |
| MAR 2027 SR3H7 | OPT | | 96.94 | +0.11 (+0.11%) | 96.83 | 96.865 | 96.955 | 96.845 | 82,595 | 04:22:35 CT 04 Apr 2025 |
| JUN 2027 SR3M7 | OPT | | 96.98 | +0.11 (+0.11%) | 96.79 | 96.82 | 96.915 | 96.88 | 68,748 | 04:22:35 CT 04 Apr 2025 |
| SEP 2027 SR3U7 | OPT | | 96.86 | +0.11 (+0.11%) | 96.75 | 96.775 | 96.875 | 96.76 | 45,868 | 04:22:51 CT 04 Apr 2025 |
| DEC 2027 SR3Z7 | OPT | | 96.825 | +0.115 (+0.12%) | 96.71 | 96.735 | 96.835 | 96.72 | 54,161 | 04:22:43 CT 04 Apr 2025 |
| MAR 2028 SR3H8 | OPT | | 96.785 | +0.115 (+0.12%) | 96.67 | 96.695 | 96.79 | 96.675 | 48,689 | 04:22:35 CT 04 Apr 2025 |
| JUN 2028 SR3M8 | OPT | | 96.745 | +0.115 (+0.12%) | 96.63 | 96.655 | 96.755 | 96.635 | 24,747 | 04:22:43 CT 04 Apr 2025 |
| SEP 2028 SR3U8 | OPT | | 96.71 | +0.12 (+0.12%) | 96.59 | 96.615 | 96.715 | 96.60 | 19,822 | 04:22:56 CT 04 Apr 2025 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SEP 2028 SR3U8 | OPT | | 96.71 | +0.12 (+0.12%) | 96.59 | 96.615 | 96.715 | 96.60 | 19,822 | 04:22:56 CT 04 Apr 2025 |
| DEC 2028 SR3Z8 | OPT | | 96.67 | +0.12 (+0.12%) | 96.55 | 96.575 | 96.675 | 96.56 | 26,451 | 04:22:35 CT 04 Apr 2025 |
| MAR 2029 SR3H9 | OPT | | 96.635 | +0.12 (+0.12%) | 96.515 | 96.54 | 96.64 | 96.52 | 17,363 | 04:22:35 CT 04 Apr 2025 |
| JUN 2029 SR3M9 | OPT | | 96.59 | +0.115 (+0.12%) | 96.475 | 96.495 | 96.595 | 96.48 | 12,254 | 04:22:35 CT 04 Apr 2025 |
| SEP 2029 SR3U9 | OPT | | 96.545 | +0.115 (+0.12%) | 96.43 | 96.45 | 96.55 | 96.435 | 11,352 | 04:22:35 CT 04 Apr 2025 |
| DEC 2029 SR3Z9 | OPT | | 96.505 | +0.12 (+0.12%) | 96.385 | 96.405 | 96.51 | 96.39 | 14,557 | 04:22:49 CT 04 Apr 2025 |
| MAR 2030 SR3H0 | OPT | | 96.465 | +0.12 (+0.12%) | 96.345 | 96.365 | 96.47 | 96.35 | 10,598 | 04:22:35 CT 04 Apr 2025 |
| JUN 2030 SR3M0 | OPT | | 96.405 | +0.10 (+0.10%) | 96.305 | 96.315 | 96.41 | 96.315 | 132 | 02:38:48 CT 04 Apr 2025 |
| SEP 2030 SR3U0 | OPT | | 96.37 | +0.105 (+0.11%) | 96.265 | 96.37 | 96.37 | 96.37 | 2 | 02:13:39 CT 04 Apr 2025 |
| DEC 2030 SR3Z0 | OPT | | - | - | 96.23 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| MAR 2031 SR3H1 | OPT | | 96.28 | +0.08 (+0.08%) | 96.20 | 96.28 | 96.28 | 96.28 | 25 | 02:04:14 CT 04 Apr 2025 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| JUN 2031 SR3M1 | OPT | | - | - | 96.17 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| SEP 2031 SR3U1 | OPT | | - | - | 96.135 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| DEC 2031 SR3Z1 | OPT | | - | - | 96.11 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| MAR 2032 SR3H2 | OPT | | - | - | 96.085 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| JUN 2032 SR3M2 | OPT | | - | - | 96.06 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| SEP 2032 SR3U2 | OPT | | - | - | 96.04 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| DEC 2032 SR3Z2 | OPT | | - | - | 96.005 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| MAR 2033 SR3H3 | OPT | | - | - | 96.00 | - | - | - | 0 | 21:34:17 CT 03 Apr 2025 |
| JUN 2033 SR3M3 | OPT | | - | - | 96.00 | - | - | - | 0 | 17:57:53 CT 03 Apr 2025 |
| SEP 2033 SR3U3 | OPT | | - | - | 96.01 | - | - | - | 0 | 17:58:10 CT 03 Apr 2025 |
| DEC 2033 SR3Z3 | OPT | | - | - | 95.965 | - | - | - | 0 | 17:57:38 CT 03 Apr 2025 |


| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DEC 2033 SR3Z3 | OPT | | - | - | 95.965 | - | - | - | 0 | 17:57:38 CT 03 Apr 2025 |

| MAR 2034 SR3H4 | OPT | | - | - | 95.99 | - | - | - | 0 | 17:57:39 CT 03 Apr 2025 |
|---|---|---|---|---|---|---|---|---|---|---|
| JUN 2034 SR3M4 | OPT | | - | - | 95.99 | - | - | - | 0 | 17:57:06 CT 03 Apr 2025 |
| SEP 2034 SR3U4 | OPT | | - | - | 96.00 | - | - | - | 0 | 17:57:53 CT 03 Apr 2025 |

3. Implied 3-month SOFRs were calculated using (100 - Price_Settle)%
4. Corresponding settlement dates SR3 Futures were obtained from the website link given, taken from “SETTLEMENT” columns
5. Number of days were computed from differences in the settlement dates. For the very first contract, settlement date was calculated from 18th June 2025.

| Contract Sign Month | Prior_Settle Futures Pirce | Implied 3-Month SOFR | Settlement Date | Num Days in Contract Quarter |
|---|---|---|---|---|
| Jun-25 | 95.970 | =100-C5 | 17/9/2025 | 91 |
| Sep-25 | 96.315 | 3.685 | 17/12/2025 | 91 |
| Dec-25 | 96.565 | 3.435 | 18/3/2026 | 91 |

Figure 1. Shows Results of Part 1 Stage 1.2 to Stage 1.5

## Part 1 Stage 2

Equation Used

$$FirstEquation->\left(1+\frac{\text{TotalDays}_T}{360}\cdot\text{forwardRate}_T\right)=\left(1+\frac{\text{TotalDays}_{T-1}}{360}\cdot\text{forwardRate}_{T-1}\right)\cdot\left(1+\frac{\text{DaysInContract}_T}{360}\cdot\text{3M\_SOFRRate}_T\right)$$

$$forwardRate_T=(RHS-1)*(360/cumulativeDays)*100$$

- Using the first equation, I found the forwardRate_T at each time step for different contract, reference dates starting from 18-Jun 2025.
- I did this by finding total accumulation from forwardRate_T-1 (ends 3M earlier) multiplied by accumulation from the latest contract period. I set this

as my right hand side.

- Then I simply found the forwardRate_T if this rate was used, that will help me make the same amount of accumulation in the same total number of days.
- I used a VBA subroutine to find term structures for the different reference dates

Let the implied forward 6-month term-SOFR be $r$. Then we have

$$\left(1+\frac{92+91}{360}r\right)=\left(1+\frac{92}{360}\times 6.48\%\right)\left(1+\frac{91}{360}\times 6.70\%\right).$$

$$r=\left[\left(1+\frac{92}{360}\times 6.48\%\right)\left(1+\frac{91}{360}\times 6.70\%\right)-1\right]\times\frac{360}{183}$$
$$=6.645\%.$$

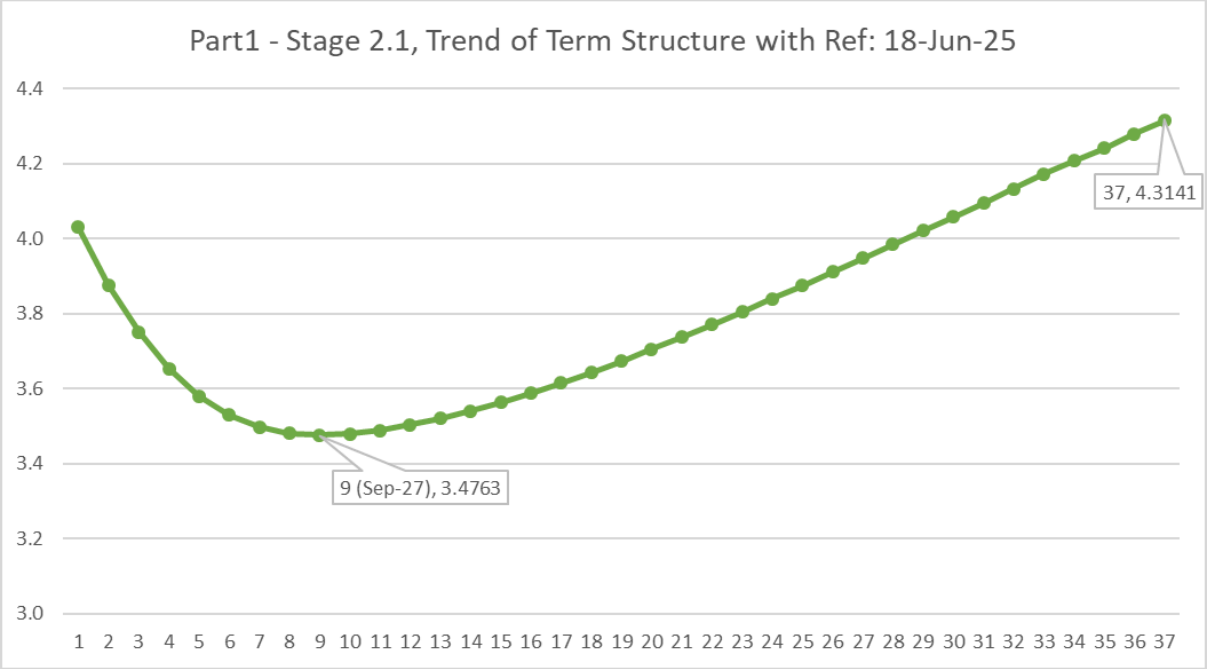
My formula was inspired *from QF3101 Chapter 2 - pg 56 ^*

Part1 - Stage 2

| Term Structure Ref: 18-Jun-25 | Term Structure Ref: 17-Sep-25 | Term Structure Ref: 17-Dec-25 | Term Structure Ref: 18-Mar-26 | Term Structure Ref: 17-Jun-26 |
|---|---|---|---|---|
| 4.0300 | | | | |
| 3.8763 | 3.6850 | | | |
| 3.7516 | 3.5760 | 3.4350 | | |
| 3.6532 | 3.4920 | 3.3642 | 3.2650 | |
| 3.5800 | 3.4325 | 3.3174 | 3.2306 | 3.1700 |
| 3.5294 | 3.3948 | 3.2915 | 3.2158 | 3.1651 |
| 3.4978 | 3.3747 | 3.2821 | 3.2160 | 3.1735 |

Results

## Stage 2.1

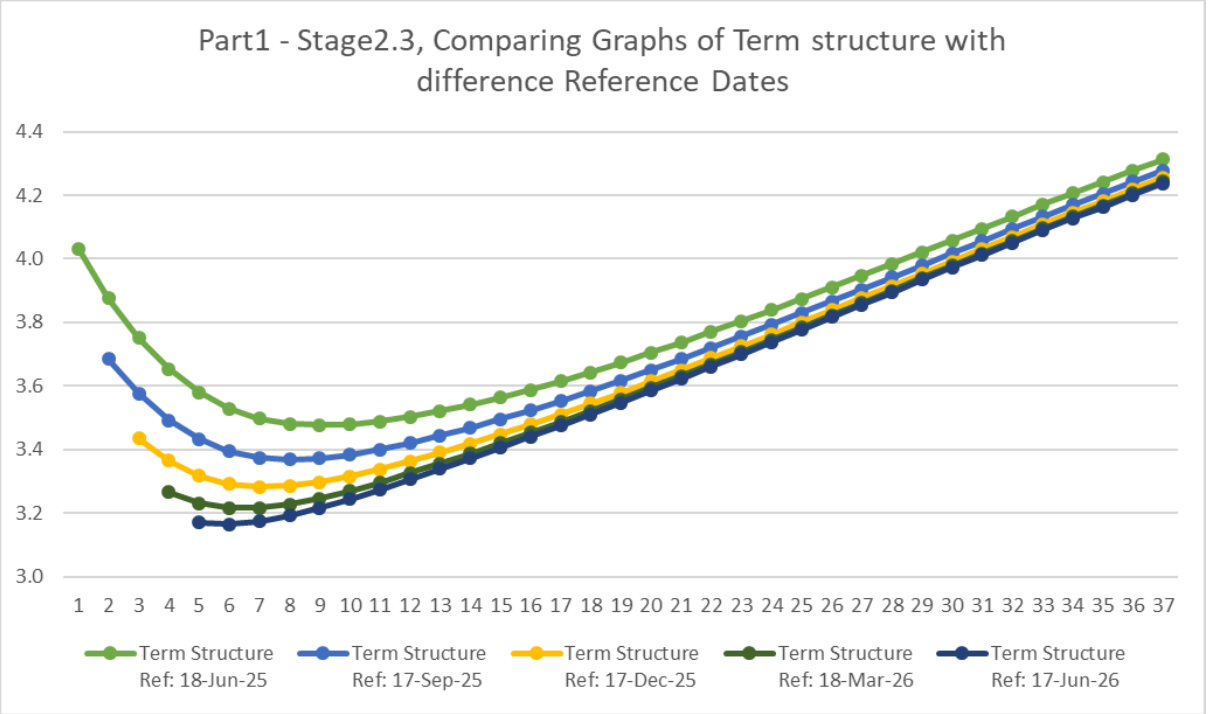



X axis Represents number of months from 18/6/2025. Y axis is the Implied SOFR Rates

## Stage 2.2

- A U-shape trend is observed where forward SOFR rates fall and then rise. The drop in forward SOFR Rates atleast in the short term, could be due to Trump's desire to ask the Federal Reserve to stimulate the slowing US economy.
- Decreasing Interval is from 18-Jun-25 to September-2027, after which until 20-Sep-34, the rates increase.
- The following increase can be attributed to the economy recovering and the macro-economic policy by the FEDS is now instead to reduce inflation due to economic growth from the period of lower SOFR rates. Turning point is for term structure ending at 9-Sep-27 were SOFR is 3.476%

## Stage 2.3




- The graphs of different reference rates are stable since there is some consensus for the long term rates in the future. This is shown from the lines's rising in the same trend roughly from the 20th month and getting closer.
- But the near-term rates tend to vary widely due to short term uncertainty. You can see the start rates of Term Structures with different reference dates dropping as they are a reflection of future expectations of SOFR rates. This matches the decrease for the term structure starting from 18-Jun-25.

Stage 2.4

- Personally, I believe that short-term interest rates are highly sensitive to changing economic conditions, particularly in the current tumultuous economic climate. These rates quickly respond to market expectations around inflation, central bank decisions, and immediate macroeconomic indicators.
- In contrast, long-term interest rates reflect structural beliefs about the economy's future trajectory. They encapsulate how investors and policymakers view the long-term U.S. economy

- Most investors strongly believe that the American economy will weather this short-term slowdown and emerge stronger, supported by structural advantages like productivity growth & innovation. This optimism leads to expectations of higher long-term growth, which in turn justifies higher long-term interest rates.

## Part 1 Stage 3

Stage 3.1

$$X = \left( \frac{d_{0,T}}{d_{0,T+m}} - 1 \right) \times \frac{360}{m}.$$

Inspired by QF3101 Chapter 2 Page 89 ^

$$FRA\ Rate = \left( \frac{d_{0,T}}{d_{0,T+m}} - 1 \right) \times \frac{360}{m} = \left( \frac{a_{0,T+m}}{a_{0,T}} - 1 \right) \times \frac{360}{m}$$

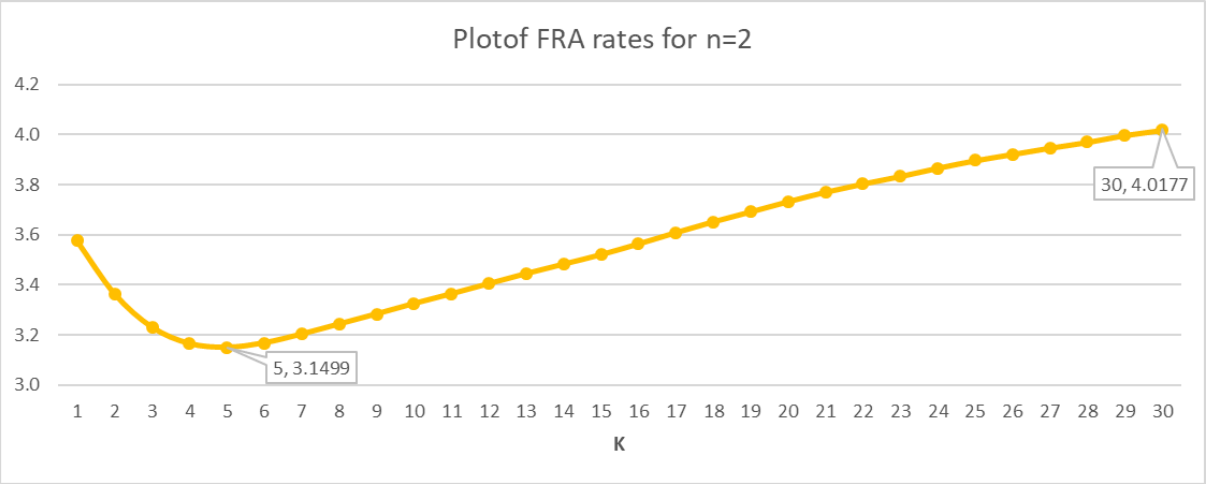
- My formula used the above FRA rate formula as reference. Accumulation from time 0 to T (denoted as a0,T), was found considering the SOFR Rate in the Term Structure till time T & total number of days from time 0 to time T.

Stage 3.2

| Fixed Rate of a deferred IxJ FRA (From 18/6/25) | | | | | |
|---|---|---|---|---|---|
| | n | 1 | 2 | 3 | 4 |
| k | I, J | J=I +3 | J=I + 6 | J=I +9 | J=I +12 |
| 1 | I=3 | 3.6850 | 3.5760 | 3.4920 | 3.4325 |
| 2 | I=6 | 3.4350 | 3.3642 | 3.3174 | 3.2915 |
| 3 | I=9 | 3.2650 | 3.2306 | 3.2158 | 3.2160 |
| 4 | I=12 | 3.1700 | 3.1651 | 3.1735 | 3.1917 |

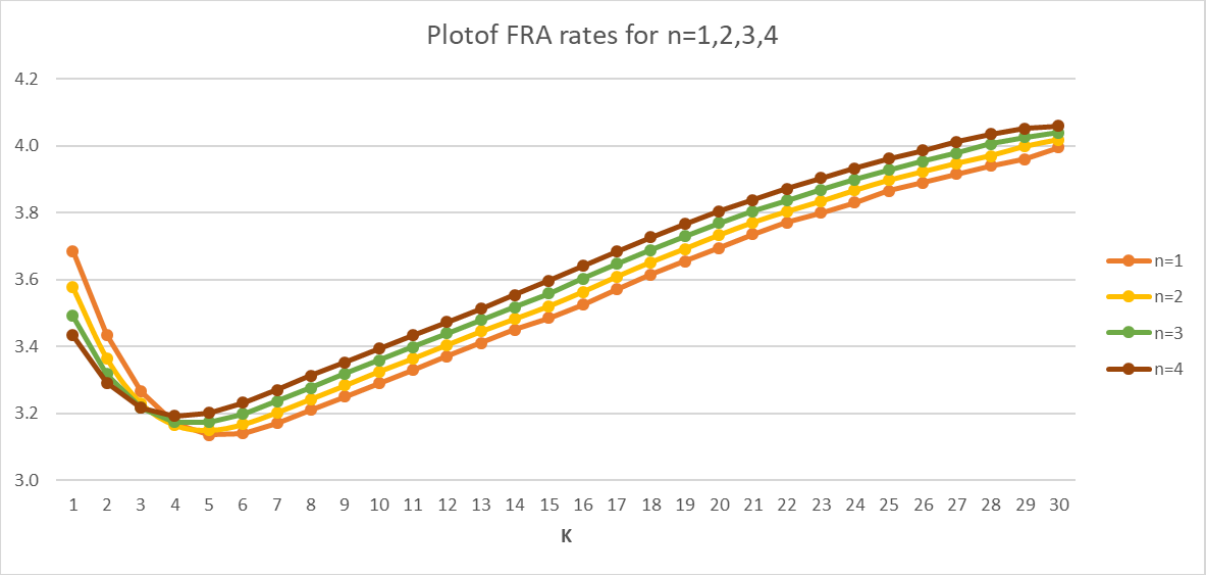
Output in Spreadsheet

## Stage 3.3




1. The plot shows a clear U-shaped curve. From K = 1 to 5, which means till 15th months from 18th Jun 25, the rates decrease till 3.15%. After which they increase steadily till K=30, to 4.02%. Turning point is at K=5, where FRA rates are the lowest.
2. 

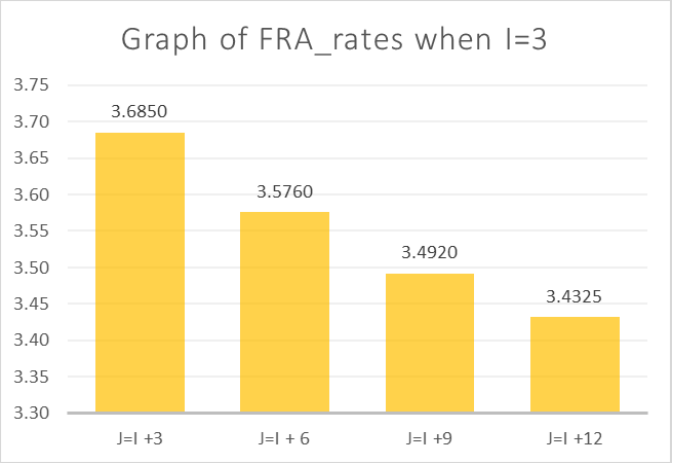
- Initial downward slope can be attributed to market expectations of short decrease in interest rates. This is largely from mild recession in the near term (JP Morgan recently increased the probability of recession from 40% to 60% after trump's hints of tariffs.
- The period of low FRA rates will make it cheaper to borrow & reduce amount in savings due to lower interests. This will boost the economy leading the stronger growth. The upward slope aligns with expectation that the FED will tighten monetary policy to curb inflationary pressure from stronger growth in the long term




3.

- ALL 4 FRA lines are stable as they all decrease in the short term & show a clear turning point at around K=4 or K=5. After which, steadily increasing almost linearly.
- The lines are stable as FRA is derived from the term structures of the same reference date of 16th Jun 25. Even though higher n considers a longer time period, as it takes data from the same term structure and consequently same SOFR curve, underlying economic expectation for inflation/economic growth remain unchanged.
- But in the short term, increasing n, has the effect of shifting the FRA curve forward where short term volatility & short lower rates gets skipped over in a sense. Hence, at the higher values of n,  longer term expectations are more represented, causing FRA rates to be a bit less volatile and consequently lower.

4.



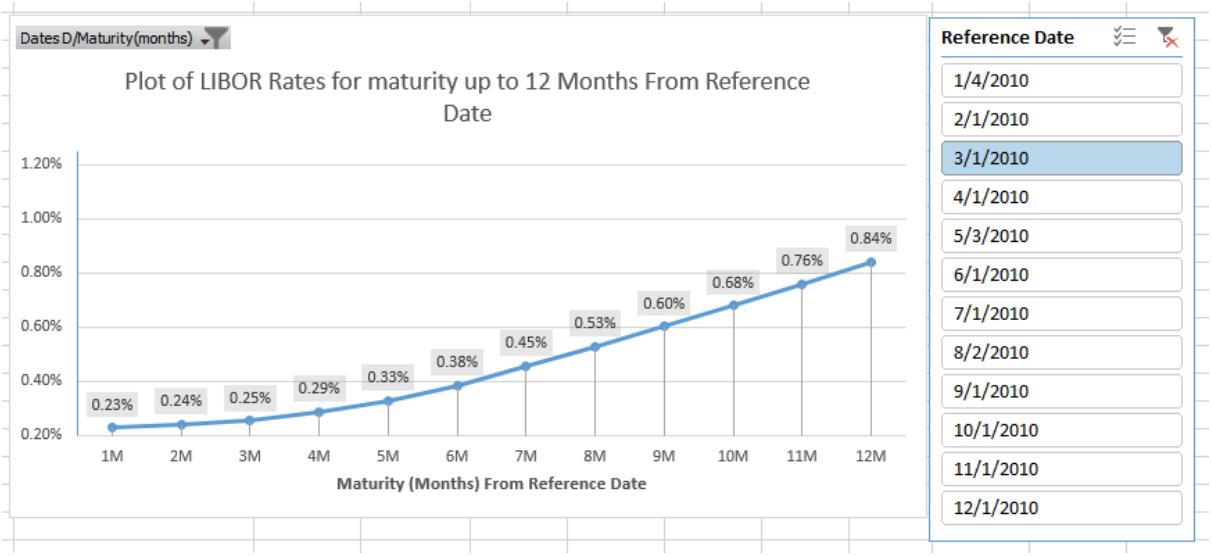

- FRA rate decreases when J increases for this I=3, because, longer FRAs exposes the seller of the FRA to more interest rate volatility, coupled with the expectation that interest rates will decrease in the short term (where I=3 from above). They are likely to price the FRA more conservatively to match expectations.

# Part 2 Stage 1

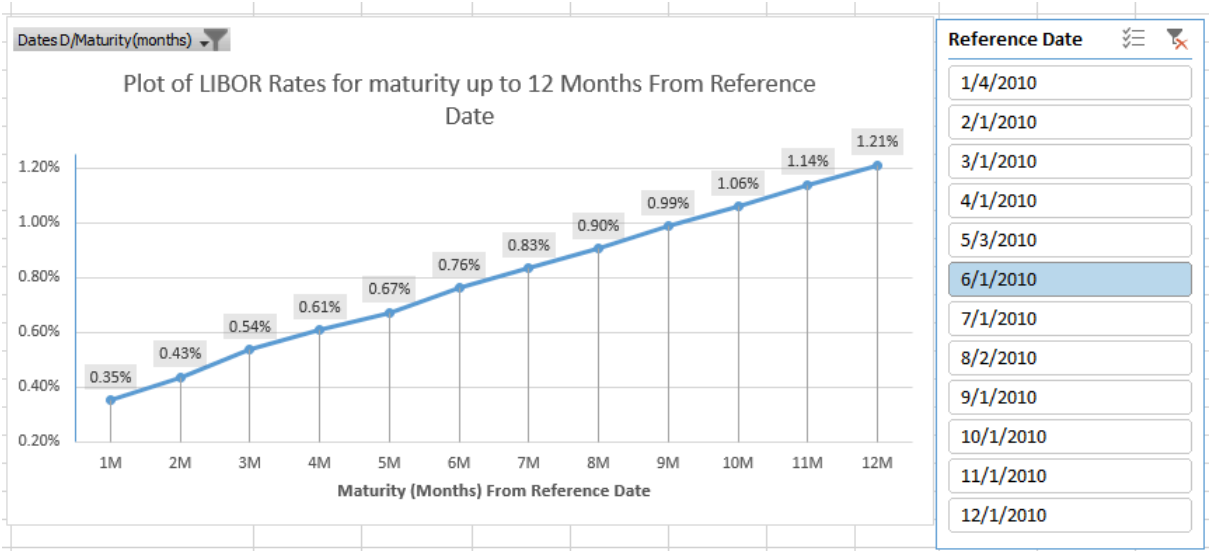
Part2 Stage 1.1

| | LIBOR Rates from Reference Date for X-month Maturity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates D/X | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1/4/2010 | 0.233% | 0.243% | 0.254% | 0.291% | 0.350% | 0.434% | 0.513% | 0.620% | 0.718% | 0.809% | 0.901% | 0.994% |
| 2/1/2010 | 0.229% | 0.239% | 0.249% | 0.276% | 0.324% | 0.384% | 0.456% | 0.534% | 0.613% | 0.691% | 0.766% | 0.843% |
| 3/1/2010 | 0.228% | 0.239% | 0.252% | 0.286% | 0.327% | 0.384% | 0.455% | 0.528% | 0.601% | 0.679% | 0.759% | 0.839% |
| 4/1/2010 | 0.249% | 0.267% | 0.292% | 0.329% | 0.371% | 0.442% | 0.516% | 0.589% | 0.671% | 0.753% | 0.834% | 0.915% |
| 5/3/2010 | 0.285% | 0.321% | 0.353% | 0.405% | 0.464% | 0.546% | 0.625% | 0.704% | 0.787% | 0.867% | 0.949% | 1.040% |
| 6/1/2010 | 0.351% | 0.434% | 0.536% | 0.608% | 0.671% | 0.761% | 0.832% | 0.904% | 0.987% | 1.059% | 1.137% | 1.209% |
| 7/1/2010 | 0.347% | 0.431% | 0.533% | 0.603% | 0.672% | 0.751% | 0.818% | 0.887% | 0.954% | 1.025% | 1.101% | 1.173% |
| 8/2/2010 | 0.303% | 0.361% | 0.445% | 0.512% | 0.581% | 0.660% | 0.719% | 0.774% | 0.828% | 0.897% | 0.966% | 1.030% |
| 9/1/2010 | 0.258% | 0.275% | 0.296% | 0.356% | 0.428% | 0.496% | 0.554% | 0.609% | 0.658% | 0.716% | 0.777% | 0.840% |
| 10/1/2010 | 0.257% | 0.274% | 0.291% | 0.345% | 0.408% | 0.463% | 0.513% | 0.564% | 0.612% | 0.665% | 0.718% | 0.778% |
| 11/1/2010 | 0.254% | 0.269% | 0.286% | 0.335% | 0.396% | 0.446% | 0.494% | 0.541% | 0.593% | 0.648% | 0.703% | 0.760% |
| 12/1/2010 | 0.265% | 0.283% | 0.303% | 0.350% | 0.411% | 0.467% | 0.519% | 0.571% | 0.622% | 0.673% | 0.729% | 0.790% |

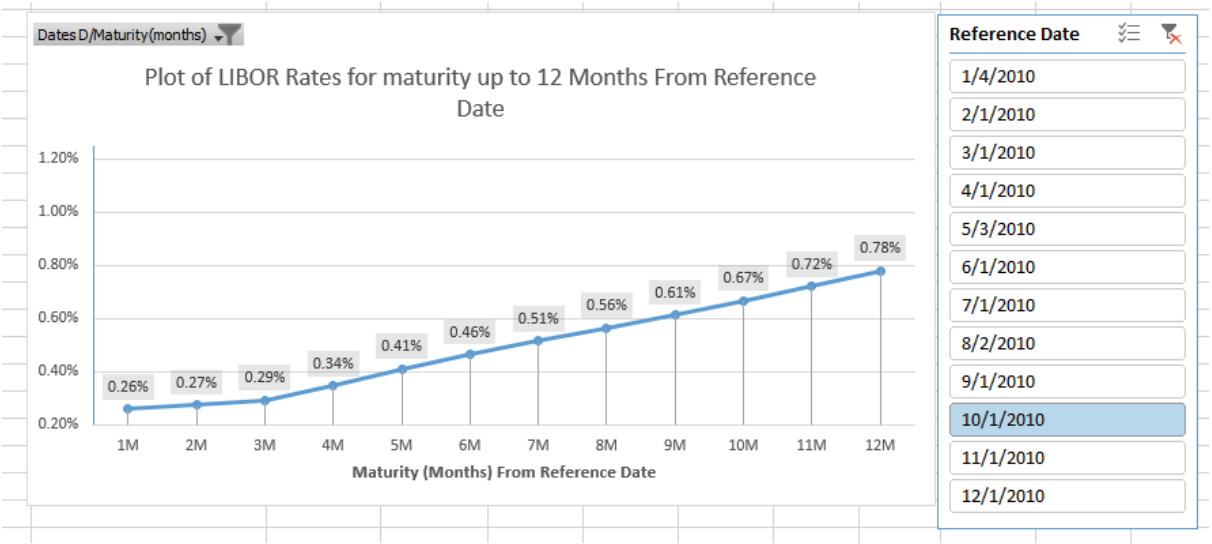
Tabulation of the 12 by 12 US LIBOR Term Structures obtained



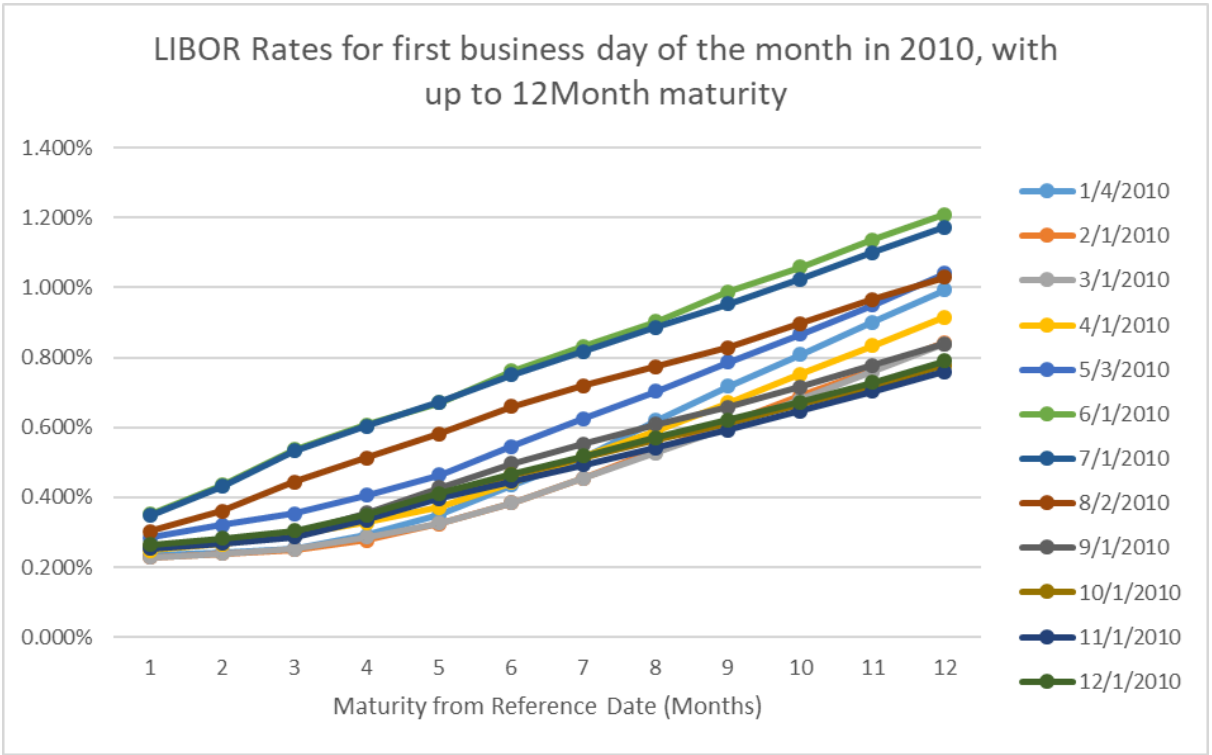

Plot of LIBOR Rates with Reference Date of 1st March 2010 → IN 2010 QUARTER 1




Plot of LIBOR Rates with Reference Date of 1st June 2010




Plot of LIBOR Rates with Reference Date of 1st October 2010




Combined Line Chart of maturity of the 12 term strucutres

| Dates D/Matur | Spread of Max-Min |
|---|---|
| 1/4/2010 | 0.76% |
| 2/1/2010 | 0.61% |
| 3/1/2010 | 0.61% |
| 4/1/2010 | 0.67% |
| 5/3/2010 | 0.76% |
| 6/1/2010 | 0.86% |
| 7/1/2010 | 0.83% |
| 8/2/2010 | 0.73% |
| 9/1/2010 | 0.58% |
| 10/1/2010 | 0.52% |
| 11/1/2010 | 0.51% |
| 12/1/2010 | 0.52% |

Spread (max - min of LIBOR rate) for the different term structures

- Charts were created using Excel PivotCharts for greater ease of toggling to find the different term structures in the year
- All 12 Month Term Structures exhibit an upward trend, reflecting a normal yield curve throughout the 12 Months. This may indicate that due to expected positive economic growth, market expectations are that future rate will increase.
- Jan-Mar 2010 typically exhibits flatter curves, suggesting low interest rates in a post 2008 financial crisis environment. However, from May to Aug 2010, 1M Libor increases to 0.35% while 12M rates shoots up above 1%
- With spread (max-min for Ref Date) in this period, being the highest in the year at around 80 basis points (0.8%). This suggests that economy may have recovered from the period of low interest rates from economy recovering & from quantitative easing and rates will be increased by the federal reserve to combat inflation.
- From Sep to Dec 2010, we can see the rates dropping back but still slightly higher than 2010Q1 (both short term & long term) and the spread decreasing to around 50 basis points, suggesting more economic caution or reduced inflation.

Part2 Stage 1.2

How Number of Days for each Month of Maturity from Reference Date was calculated

| Set | Set | Ref Date/Mat | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| | D | 1/4/2010 | 28 | 56 | 87 | 119 | 148 | 178 |
| | | 2/1/2010 | 28 | 59 | 91 | 120 | 150 | 182 |
| | | 3/1/2010 | 31 | 63 | 92 | 122 | 154 | 184 |
| | | 4/1/2010 | 32 | 61 | 91 | 123 | 153 | 183 |
| | | 5/3/2010 | 29 | 59 | 91 | 121 | 151 | 182 |
| | | 6/1/2010 | 30 | 62 | 92 | 122 | 153 | 183 |
| | | 7/1/2010 | 32 | 62 | 92 | 123 | 153 | 186 |
| | | 8/2/2010 | 30 | 60 | 91 | 121 | 154 | 183 |
| | | 9/1/2010 | 30 | 61 | 91 | 124 | 153 | 181 |
| | | 10/1/2010 | 31 | 61 | 94 | 123 | 151 | 182 |
| | | 11/1/2010 | 30 | 63 | 92 | 120 | 151 | 182 |
| E | | 12/1/2010 | 33 | 62 | 90 | 121 | 152 | 184 |
| | | 1/3/2011 | | | | | | |
| | | 2/1/2011 | | | | | | |
| | | 3/1/2011 | | | | | | |

Part 1 Stage 1.3

| | Number of Days from Reference Date fo | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 | 1 | 2 | 3 | 4 | 5 | 6 | |
| 0.994% | 28 | 56 | 87 | 119 | 148 | 178 | |
| 0.843% | 28 | 59 | 91 | 120 | 150 | 182 | |
| 0.839% | 31 | 63 | 92 | 122 | 154 | 184 | |
| 0.915% | 32 | 61 | 91 | 123 | 153 | 183 | |
| 1.040% | 29 | 59 | 91 | 121 | 151 | 182 | |
| 1.209% | 30 | 62 | 92 | 122 | 153 | 183 | |
| 1.173% | 32 | 62 | 92 | 123 | 153 | 186 | |
| 1.030% | 30 | 60 | 91 | 121 | 154 | 183 | |
| 0.840% | 30 | 61 | 91 | 124 | 153 | 181 | |
| 0.778% | 31 | 61 | 94 | 123 | 151 | 182 | |
| 0.760% | 30 | 63 | 92 | 120 | 151 | 182 | |
| 0.790% | 33 | 62 | 90 | 121 | 152 | 184 | |

Vectors of number-of-days being adjacent to corresponding term structures

# Part 2 Stage 2

$$d_{0,k} = \frac{1}{1 + \text{LiborRate}(T = k) \cdot \left( \frac{\text{TotalNumDays}_{from\ 0,k}}{360} \right)}$$

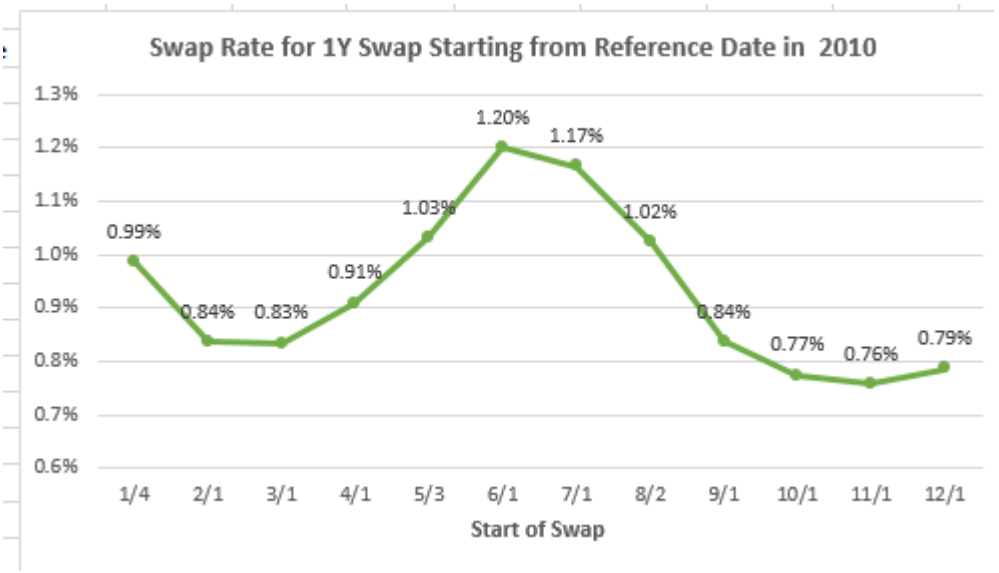
$$\text{Since } @T = 0, \text{SwapValue} = 0$$
$$\Rightarrow \text{SwapRate} = \frac{1 - d_{0,k}}{\sum_{i=1}^{12} d_{0,i} \cdot \frac{\text{TotalNumDays}_{from\ i-1,i}}{360}}$$

Rationale for the above, is we use the same formula as *qf3101 chapter 3 page 20,22*, where 1 fixed payment was considered to be Nr , where payment was yearly. Here, 1 fixed payment is not Nr but rather **N * (LiborRate (T=i)) * (Days Between maturity at i-1 & i) / 360**. This helps us to find payment just from each month.

Stage 2.2

| Part2 Stage 2 | | |
|---|---|---|
| mm/dd of Start | Swap Start Da | 1Y Swap Term - Swap |
| 1/4 | 1/4/2010 | 0.987% |
| 2/1 | 2/1/2010 | 0.838% |
| 3/1 | 3/1/2010 | 0.835% |
| 4/1 | 4/1/2010 | 0.910% |
| 5/3 | 5/3/2010 | 1.033% |
| 6/1 | 6/1/2010 | 1.200% |
| 7/1 | 7/1/2010 | 1.165% |
| 8/2 | 8/2/2010 | 1.024% |
| 9/1 | 9/1/2010 | 0.836% |
| 10/1 | 10/1/2010 | 0.775% |
| 11/1 | 11/1/2010 | 0.757% |
| 12/1 | 12/1/2010 | 0.786% |

Stage 2.3




- The trend recorded a decline in 2010 Q1 from 0.99% to 0.83%. Before rising sharply to 1.20% by end of Q2. It then declined to a low of 0.76% in November rising slightly to 0.79% in december.
- Swap Rates are influenced by predictions & existing LIBOR rates. In Q1, the economy was still recovering from post 2008 financial crisis and hence due to slow recovery & low inflation, the swap rates reflected the low short term interest rates.
- But in Q2 2010, economic metrics like GDP increased feelings of market recovery. This led to belief that the federal reserve will tighten its monetary policy by increasing interest rates. And hence, leading to an uptick in swap rates in Q2 2010.
- However, in the 2nd half of 2010, economy momentum slowed down with lower GDP growth than Q2. Hence, the federal reserve did its second round of quantitative easing announced in Nov 2010, causing higher market liquidity and hence pushing interest rates up slightly due to expectations that this will boost the economic recovery efforts

## Part 2 Stage 3

Considering a Party that receives fixed rate payments & pays floating rate payments, with $1 Notional Principal

$$B_{fl} = (N + f_1)e^{-r_1 t_1}$$

fixed rate bond is valued at time 0 a

$$B_{fix} = Ne^{-r_n t_n} + \sum_{i=1}^{n} ke^{-r_i t_i}.$$

^ QF3101 Chapter 3 Page 25. The above formulas were used as inspiration BUT fixed swap rate was assumed to be continuously compounded while it was (actual/360) in the homework. Hence we simply just replace discounting of **(e ^ r * t) with discounting appropriate to this task. Discounting for this task considers the number of days between each period**

- For the floating rate bond, I simply find the present value of the principal & very next payment to time t.
- While for the fixed rate bond, I find **PV(principal)** to time t and **summation of PV(all the fixed rate payments after time t)** to time t

> 💡 **Value of swap** at time t = **Value of fixed rate bond** at time t **-** V**alue of floating rate bond** at time t

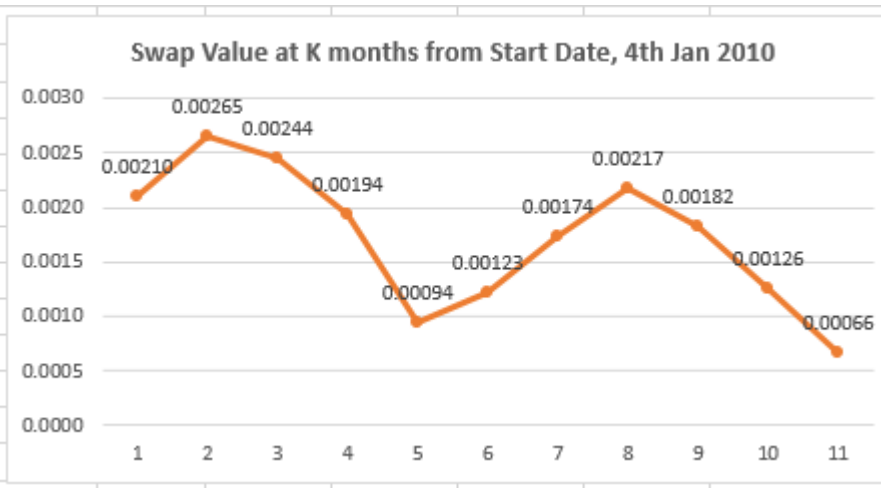
This gives us

$$\{B_{\text{float}} \text{ at time } T\} = \frac{\text{Principal} + \text{1stPayment\_AfterT}}{\text{LiborRate}(T+1) \cdot \frac{\text{Number of days from 0 to } T+1}{360}}$$

Stage 3.2

| Swap Start Date | K | Swap Value at K months from Start Date |
|---|---|---|
| 1/4/2010 | 1 | 0.00210 |
| | 2 | 0.00265 |
| | 3 | 0.00244 |
| | 4 | 0.00194 |
| | 5 | 0.00094 |
| | 6 | 0.00123 |
| | 7 | 0.00174 |
| | 8 | 0.00217 |
| | 9 | 0.00182 |
| | 10 | 0.00126 |
| | 11 | 0.00066 |

Stage 3.3




- This line has a wavy but overall decreasing trend. The peaks were at K=2 with value of0.00265 and at k = 8 with value of 0.00217. There was a local minima at K=5 at 0.00094. Swap value increases till K =2 before declining sharply till K = 5, it increases again till K = 8, before decreasing
- Since swap value is positive, value of fixed rate bond is higher than than that of floating rate bond. But trend is downwards, due to decreasing value in the fixed rate bond over time, as there are fewer remaining payments. This is not unexpected as swap value tends to 0 regardless of rate expectations due to fewer cash flows.

Part2 Stage 1.1

| | LIBOR Rates from Reference Date for X-month Maturity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dates D/X | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1/4/2010 | 0.233% | 0.243% | 0.254% | 0.291% | 0.350% | 0.434% | 0.513% | 0.620% | 0.718 |
| 2/1/2010 | 0.229% | 0.239% | 0.249% | 0.276% | 0.324% | 0.384% | 0.456% | 0.534% | 0.613 |
| 3/1/2010 | 0.228% | 0.239% | 0.252% | 0.286% | 0.327% | 0.384% | 0.455% | 0.528% | 0.601 |
| 4/1/2010 | 0.249% | 0.267% | 0.292% | 0.329% | 0.371% | 0.442% | 0.516% | 0.589% | 0.671 |
| 5/3/2010 | 0.285% | 0.321% | 0.353% | 0.405% | 0.464% | 0.546% | 0.625% | 0.704% | 0.787 |
| 6/1/2010 | 0.351% | 0.434% | 0.536% | 0.608% | 0.671% | 0.761% | 0.832% | 0.904% | 0.987 |
| 7/1/2010 | 0.347% | 0.431% | 0.533% | 0.603% | 0.672% | 0.751% | 0.818% | 0.887% | 0.954 |
| 8/2/2010 | 0.303% | 0.361% | 0.445% | 0.512% | 0.581% | 0.660% | 0.719% | 0.774% | 0.828 |
| 9/1/2010 | 0.258% | 0.275% | 0.296% | 0.356% | 0.428% | 0.496% | 0.554% | 0.609% | 0.658 |

- The increase in swap value from K=5 to K=8 can be attributed to LIBOR rates during 2010 Q3 flattening (highlighted above ^) which causes the value of the floating rate bond to drop. This results in higher swap value for that period of time.
- Since WE pay floating rates while receiving the same fixed rate, this makes our swap more valuable.