Class 4: Interest Rate Swaps
Financial Markets, Spring 2021, SAIF

Jun Pan

Shanghai Advanced Institute of Finance (SAIF)
Shanghai Jiao Tong University

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Outline

- Global OTC derivatives: notional amounts $640T and gross market value $12.1T.
  - An important component of the market infrastructure.
  - The preferred hedging instruments for interest-rate and currency risks.
- Interest-rate swaps, notional amounts of $524T.
  - Reference floating rates: LIBOR and SOFR.
  - TED spread: 3M LIBOR minus 3M Treasury bill.
  - Swap spread: swap rate minus Treasury yield of the same maturity.
- Mortgage lenders and their interest rate exposures:
  - The prepayment options by mortgage borrowers.
  - Negative convexity of MBS.
  - Hedging interest-rate exposures using interest-rate swaps.
Modern Finance: Theory, Practice, and Lessons

- Investments and Capital Structure (Modigliani and Miller)
- Two-Fund Separation (Tobin)
- CAPM (Sharpe)
- Efficient Markets Hypothesis (Samuelson, Fama)
- Portfolio Theory (Markowitz)
- First US Options Exchange, CBOE
- 1971 Birth of Index Funds (McQuown)
- Option Pricing Theory (Black, Scholes, Merton)
- 1973 First TIPS
- 1981-1982 First Stock Index Futures
- 1994-1995 Large Derivatives Losses
- 2008-2009 Financial Crisis
- 2015-2016 Trump Trade War
- 1950-1982 Mortgage Backed Securities (Fannie Mae)
- 1987-2002 OTC Derivatives
- 1992-2010 First Stock Index Futures
- 1998-2006 Enron Scandal
- 2007-2008 Dot-Com Peak
- 2008-2009 Global Financial Crisis
- 2010-2013 European Sovereign Crisis
- 2015-2016 Trump Trade War
- 1955-1979 Mortgage-Backed Securities (Fannie Mae)
- 1980-2007 Interest Rate Swaps
- 1990-2008 Credit Derivatives (CDS)
- 2000-2007 WorldCom Scandal
- 2002-2008 Dodd-Frank
### Derivatives Usage by Global Fortune 500 Firms

<table>
<thead>
<tr>
<th>Usage by industry</th>
<th>Usage by product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>98%</td>
</tr>
<tr>
<td>Basic materials</td>
<td>97%</td>
</tr>
<tr>
<td>Tech.</td>
<td>95%</td>
</tr>
<tr>
<td>Industrial goods</td>
<td>92%</td>
</tr>
<tr>
<td>Health care</td>
<td>92%</td>
</tr>
<tr>
<td>Utilities</td>
<td>92%</td>
</tr>
<tr>
<td>Consumer goods</td>
<td>91%</td>
</tr>
<tr>
<td>Services</td>
<td>88%</td>
</tr>
<tr>
<td><strong>Total usage across all industries:</strong></td>
<td><strong>94%</strong></td>
</tr>
<tr>
<td>FX</td>
<td>88%</td>
</tr>
<tr>
<td>Interest rate</td>
<td>83%</td>
</tr>
<tr>
<td>Commodity</td>
<td>40%</td>
</tr>
<tr>
<td>Equity</td>
<td>29%</td>
</tr>
<tr>
<td>Credit</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: ISDA 2009 Survey
Interest Rate Swaps

A vanilla interest rate swap is an agreement between two counterparties to exchange cashflows (fixed vs floating) in the same currency. This agreement is often used by counterparties to change their fixed cashflows to floating or vice versa.

Properties
- United States Dollar
- Effective: T+2, 04/18/11
- Term: 5 YR, 04/18/16
- Quoted In: Percent

Fixed
- Day Count: 30/360
- Pay Freq: Semi-annual
- Coupon: 2.4170

Float
- Day Count: ACT/360
- Pay Freq: Quarterly
- Index: 301 US0003M
- Reset Freq: Quarterly

Ticker: DES

Benchmarked against USD 3m Libor
- Quarterly
- ACT / 360

5Y Swap Rate: 2.417% (p.a.)
- Semi-Annual
- 30/360
<table>
<thead>
<tr>
<th>Fixed</th>
<th>Floating</th>
</tr>
</thead>
</table>

Interest-Rate Swap Pricing
TED Spread: 3M LIBOR - 3M Treasury Bills

LIBOR and TBill Rates (%)

TED Spread (bps)

LIBOR and TBill Rates (%)

TED Spread (bps)
TED Spreads in 2008 and 2020

2008

2020

3M LIBOR
3M TBills
3M LIBOR - 3M TBills

Jan
Feb
Mar
Apr
May

0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

Sep 2008
Nov 2008
Jan 2009
Mar 2009
May 2009

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LIBOR/IRS and UST Curves

US Treasury Rates (%)

LIBOR/Interest-Rate Swap Rates (%)

3M
2Y
5Y
10Y
30Y

0 2 4 6 8 10 12


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Exposure to Counterparty Risk in OTC Derivatives

- At inception, swaps have zero dollar value to either parties.
- Interest rates fluctuate during the life of a swap:
  - Swap value turns positive for one counterparty and negative to the other.
  - The positive-value counterparty now has a credit exposure to his counterparty.
  - The total sum is always zero.
- To limit such counterparty credit risk:
  - Marked to the market on a monthly/daily basis.
  - Ask the negative-value counterparty to post collateral (cash or Treasury bonds).
  - Minimum rating requirements for counterparties.
  - Weaker counterparties: denied access or tighter collateral requirements.
  - Tightened collateral requirements in the event of a downgrading.
Determinants of Swap Spreads

- Counterparty risk
- Credit risk
  - The spread of three-month LIBOR (unsecured borrowing) over three-month general collateral term repo (secured borrowing).
  - The AA credit spreads
- Liquidity convenience yield of treasury bonds
  - On-off-the-run treasury bond yield differential
- Treasury supply
- Mortgage backed securities (MBS) and hedging activities
Swap Spread and Major Events

Figure 1. Evolution of Swap Spreads and Major Events, 1994 to 2004

- Treasury buyback announcement
- Monetary expansion begins
- 1998 Russian default and LTCM collapse
- MBS convexity hedging
- 1997 Asia crisis
- Y2K liquidity
MBS Negative Convexity Hedging

- Mortgage borrowers in the US have the option to prepay:
  - Falling interest rates leads to increased re-financing activities.
  - With higher probabilities of prepayment, MBS duration shortens.

- Convexity: the direction and speed at which duration moves with interest rates.

- With falling interest rates:
  - MBS: shortening duration. Negative convexity.
  - Treasuries: lengthening duration. Positive convexity.

- GSEs (Fannie Mae and Freddie Mac) are the largest buyers of US mortgages:
  - Their objective: minimize interest-rate exposures by shrinking the duration gap.
  - Use interest rate swaps and other OTC derivatives (swaptions, floors, caps):
    - Falling interest rates: buy duration via adding receive-fixed.
    - Increasing interest rates: off load duration via adding pay-fixed.
Yield and Duration, MBS vs UST

BarCap Mortgage-Backed Security

Yield (%) vs Duration (yr)

BarCap 5-Year Treasury Bellwethers

Yield (%) vs Duration (yr)
## Interest Rate Swaps

<table>
<thead>
<tr>
<th>Notional balance as of</th>
<th>Pay-Fixed</th>
<th>Receive-Fixed</th>
<th>Basis</th>
<th>Foreign Currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 31, 2008</td>
<td>$546,916</td>
<td>$451,081</td>
<td>$24,560</td>
<td>$1,652</td>
</tr>
<tr>
<td>Additions</td>
<td>297,379</td>
<td>279,854</td>
<td>2,765</td>
<td>577</td>
</tr>
<tr>
<td>Terminations</td>
<td>(461,695)</td>
<td>(455,518)</td>
<td>(24,100)</td>
<td>(692)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$277,227</strong></td>
<td><strong>$224,177</strong></td>
<td><strong>$485</strong></td>
<td><strong>$1,560</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notional balance as of</th>
<th>Pay-Fixed</th>
<th>Receive-Fixed</th>
<th>Interest Rate Swaptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 31, 2009</td>
<td>$382,600</td>
<td>$275,417</td>
<td>$99,300</td>
</tr>
<tr>
<td>Additions</td>
<td>212,214</td>
<td>250,417</td>
<td>55</td>
</tr>
<tr>
<td>Terminations</td>
<td>(317,587)</td>
<td>(301,657)</td>
<td>(2,795)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$277,227</strong></td>
<td><strong>$224,177</strong></td>
<td><strong>$485</strong></td>
</tr>
</tbody>
</table>

### Future maturities of notional amounts:

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Pay-Fixed</th>
<th>Receive-Fixed</th>
<th>Basis</th>
<th>Foreign Currency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>$70,656</td>
<td>$14,200</td>
<td>50</td>
<td>$386</td>
</tr>
<tr>
<td>1 to less than 5 years</td>
<td>90,788</td>
<td>168,000</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>5 to less than 10 years</td>
<td>96,400</td>
<td>29,632</td>
<td>100</td>
<td>511</td>
</tr>
<tr>
<td>10 years and over</td>
<td>19,383</td>
<td>12,345</td>
<td>300</td>
<td>663</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$277,227</strong></td>
<td><strong>$224,177</strong></td>
<td><strong>$485</strong></td>
<td><strong>$1,560</strong></td>
</tr>
</tbody>
</table>
Interest Rate Sensitivity of Net Portfolio, Fannie Mae 2014

<table>
<thead>
<tr>
<th>Rate level shock:</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>-100 basis points</td>
<td>$ 0.4</td>
<td>$ 0.1</td>
</tr>
<tr>
<td>-50 basis points</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>+50 basis points</td>
<td>(0.1)</td>
<td>(0.1)</td>
</tr>
<tr>
<td>+100 basis points</td>
<td>(0.1)</td>
<td>(0.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate slope shock:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-25 basis points (flattening)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>+25 basis points (steepening)</td>
<td>(0.0)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

For the Three Months Ended December 31, 2014:

<table>
<thead>
<tr>
<th>Duration Gap (In months)</th>
<th>Rate Slope Shock 25 bps</th>
<th>Rate Level Shock 50 bps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposure (Dollars in billions)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>0.1</td>
<td>$ 0.1</td>
</tr>
<tr>
<td>Minimum</td>
<td>(0.3)</td>
<td>0.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.2</td>
<td>0.0</td>
</tr>
</tbody>
</table>
MBS Footprints on Swaps

- MBS hedging: 5-10yr IRS.
- Sharp increase in 10yr in 2003:
  - Sudden spike in MBS duration.
  - Large amount of fixed-payers.
  - A temporary liquidity spike in the 10yr swap spread.
Mortgage Lenders in 2020

- Deluged with refinancing demand as rates are sharply lower:
  - Rate on 30-year fixed-rate mortgage hitting 3.29%, lowest ever recorded.
  - Refinancing applications rose 224% compared to the year prior.
  - Refinancing accounts for 75.9% of total mortgage applications.

- Facing massive margin calls amid Fed’s QE:
  - Mortgage banks are losing money on their interest-rate hedges.
  - Duration hedging: poor performance during volatile markets.
  - Also exposed:
    - Customers failed to close on loans because of quarantines.
    - Mortgage lenders stuck with the hedge without the off-setting loans.
Fed’s QE and MBS in 2020

- MBS: $10.33T as of end 2019.
- Fed announced MBS QE on 3/15.
- Week One: 3/19-25
  - increase in holdings: $1.2B.
  - decrease in yields: 100+ bps.
- Week Two: 3/26-4/1
  - increase in holdings: $55.9B.
  - decrease in yields: 4 bps.
  - 3/31: one-day spike of 41 bps!
Duration Hedging in this Environment = ?

Bloomberg BarCap MBS Yield (%)
QE Announced on 3/15

Bloomberg BarCap MBS Duration

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