Interest Rate Swaps

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Interest Rate Swaps
The Structure of a Swap

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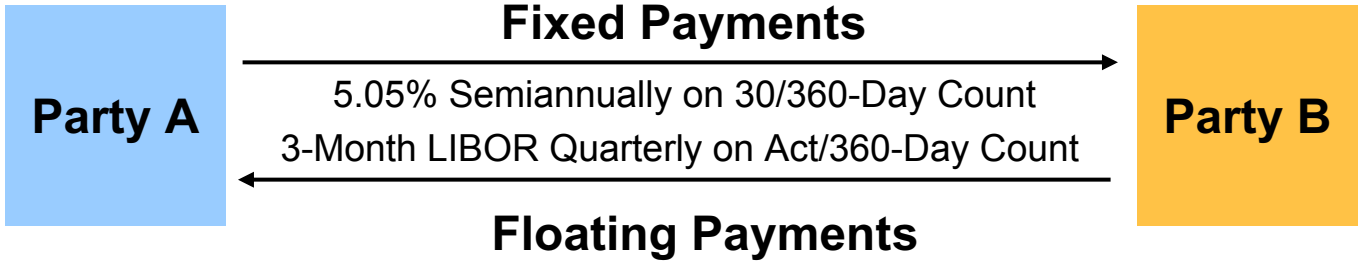
What is a Swap?

Spot-Starting 5-Year Fixed/Floating Swap ($100MM Notional)



- Swap: Contractual agreement to exchange fixed for floating cash flows over a specified period of time
- Floating rate reference: USD LIBOR
- LIBOR: British Banker Association's (BBA) fixing of the London Inter-Bank Offered Rate. A contributor bank contributes the rate at which it could borrow funds, if it were to do so by asking for and accepting inter-bank offers in reasonable market size just prior to 11 AM London time. 16 banks contribute, the top and bottom 4 fixings are eliminated, and the remaining 8 fixings are averaged.

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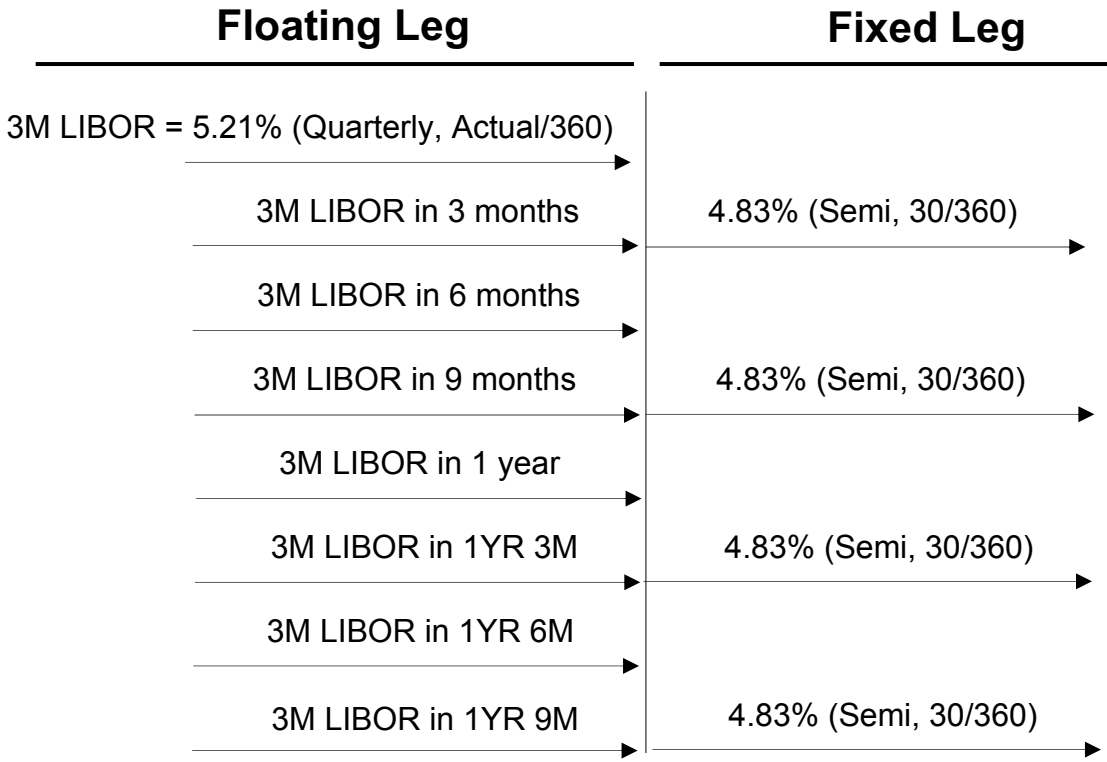
A Cashflow Example

Swap rate = average of expected LIBOR settings

Suppose You Pay Fixed on a 2-year Swap at a Rate of 4.83%



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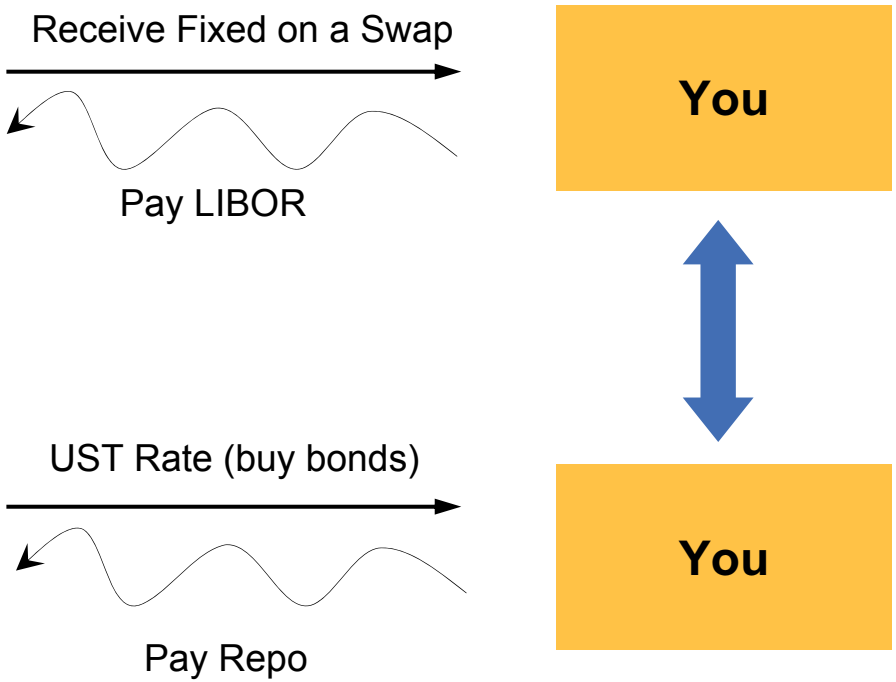
A Swap is Similar to a Leveraged Bond

Similar to a leveraged bond transaction

Swap Transaction Is Similar to a Bond Transaction Combined with 3-Month Financing



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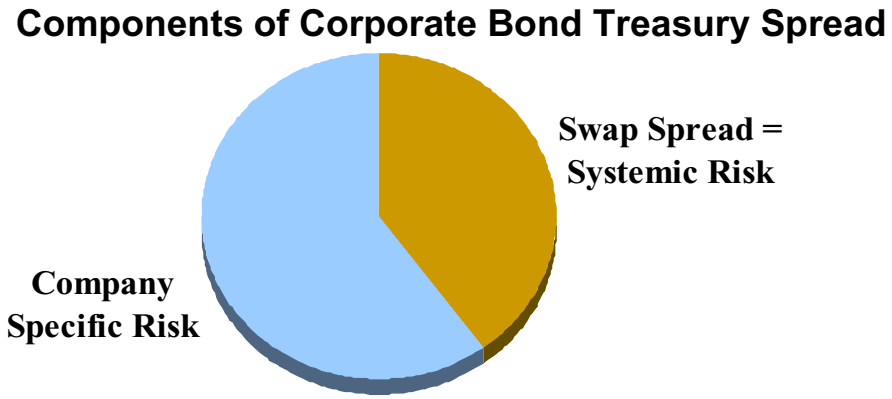
A Swap Is Different from a AA Bank Bond

An interest rate swap has different characteristics compared to a AA bank bond

- Differences between a swap contract and a AA bank bond
  - Swap: No risk of principal loss or default
  - Swap: Less risk of downgrade (if a bank is downgraded, it will be thrown out of the LIBOR panel)
  - Swap: Majority of trades are collateralized, thus reducing counterparty risk
- Result: Swap rates trade richer than AA bank credits



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Determining Future Expectations of LIBOR

- How Do We Determine Expectations of Future 3M LIBOR Settings?
- Out to 5 years, we use Eurodollar contracts:
  - Forward contracts on 3M LIBOR
  - Liquidity exists out to 5 years
  - Convexity issue
- Beyond 5 years, expected 3M LIBOR settings are implied from the swap rates.

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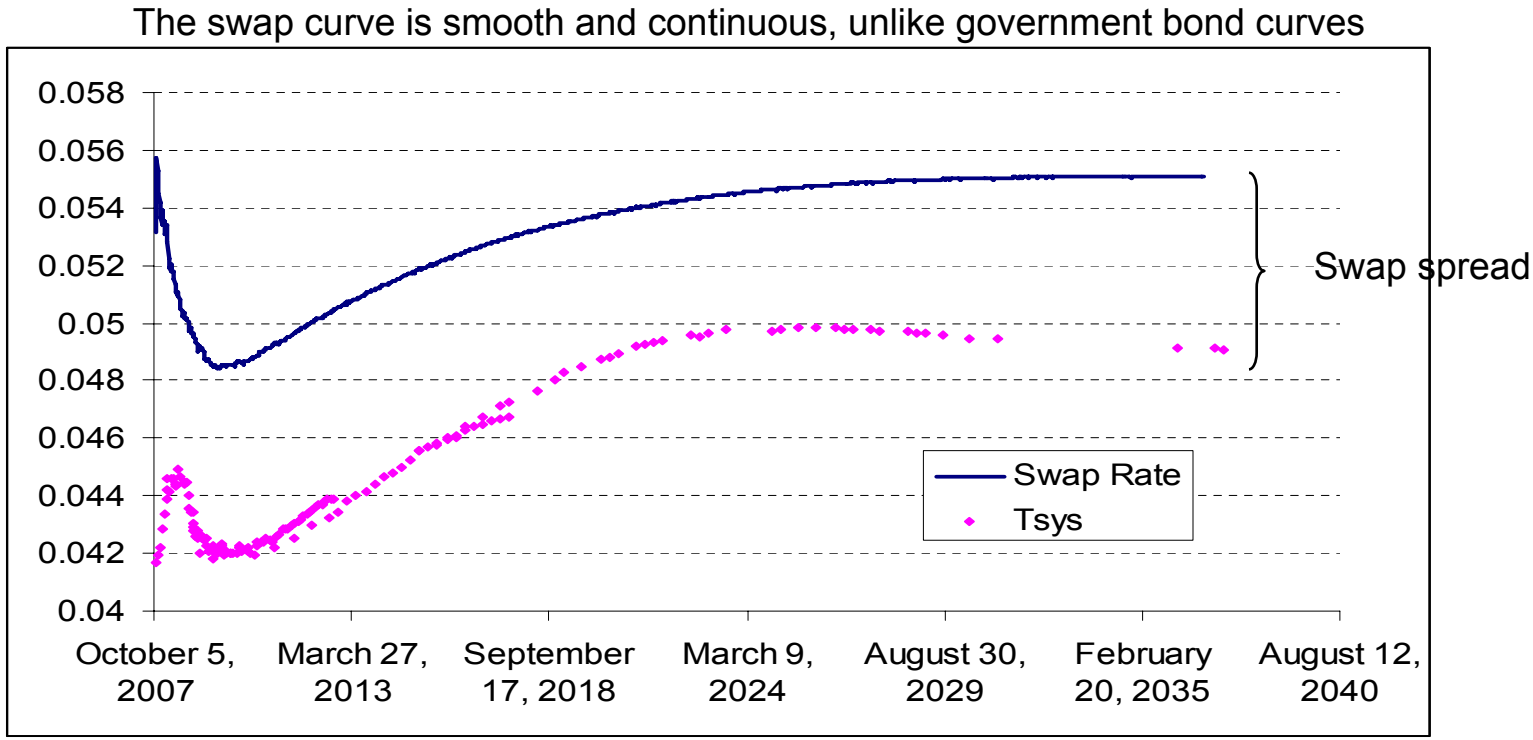
Generating the Swap Curve

From the Eurodollar Futures and Market Traded Swap Rates, a Swap Curve Is Generated



Source: Morgan Stanley

The Duration and Convexity of a Swap

- DV01 (for a bond) - The change in the price of the bond for a 1bp change in yield. To calculate shift the bond yield by 1 bp and compute the price change.
- DV01 (for a swap) - The change in PV (present value) of the swap for a 1 bp parallel shift in the swap curve.
- PV01 - The present value of a 1bp annuity with a maturity equal to the swap maturity.
- Note that for a par swap, DV01 ≈ PV01. For a swap that is not at par DV01 must be used.
- The market convention is typically to only quote the duration of the fixed leg of the swap.
- Stub risk - The duration of the floating leg of the swap, arises because once LIBOR is set it becomes a 3M fixed rate. Typically managed separately, but can be meaningful when LIBOR is volatile.
- Convexity – Change in DV01 of a swap for a 1 bp parallel shift in the swap curve.

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Who Uses Swaps and Why?

The Major Players in the Swap Market

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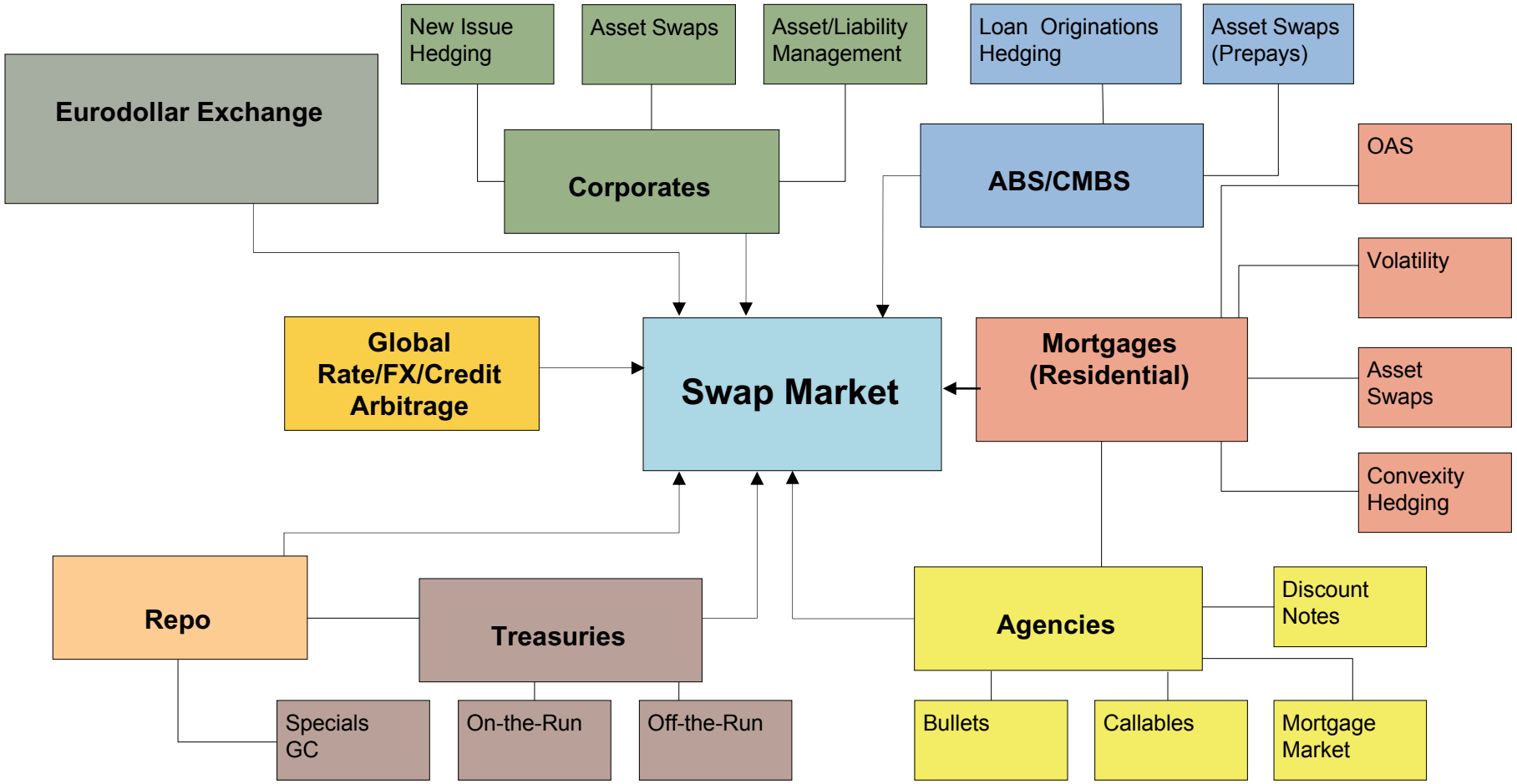
Who Uses the Swaps Market?



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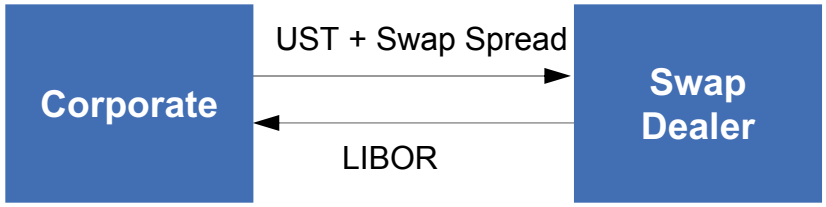
Corporation – To Hedge New or Existing Issuances

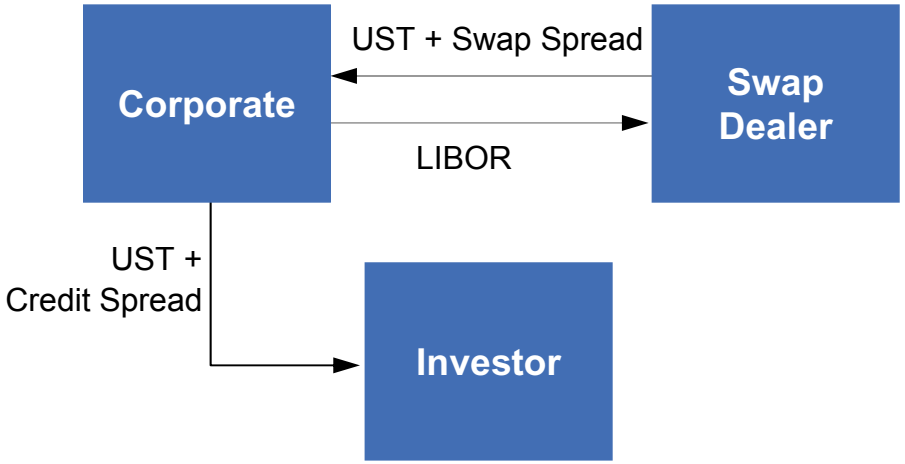
Rate Lock
Before New Issuance



Swap Spreads Widen

- Corporates pay fixed to hedge future debt issuance

Asset/Liability Management Swap
After existing Issuance



Swap Spreads Tighten

- Corporates receive fixed to achieve floating rate exposure

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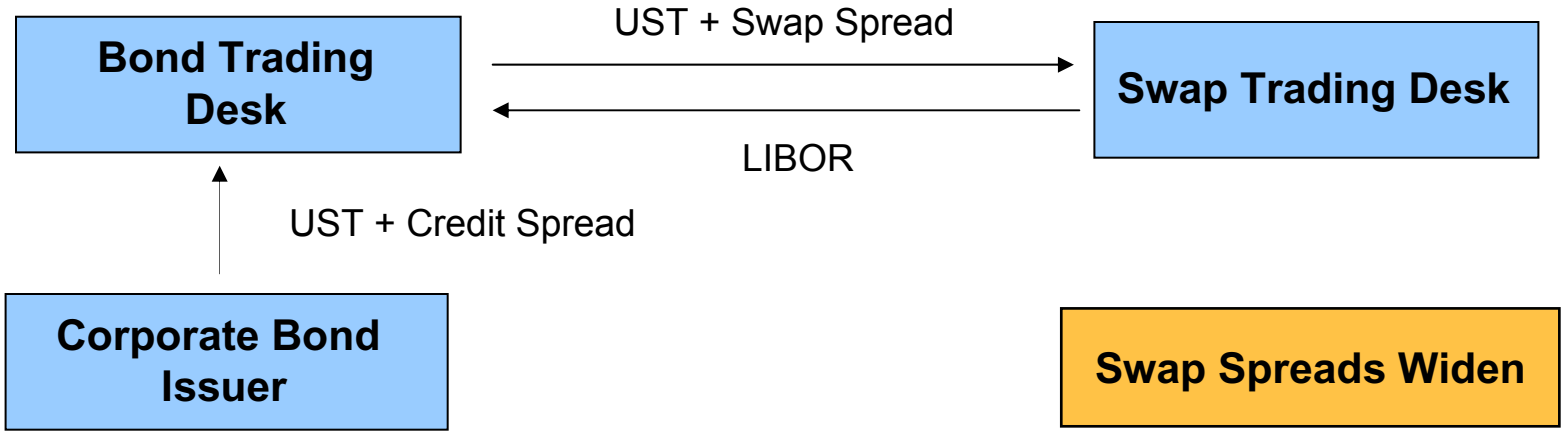
Dealers – To Hedge Inventory



- Active users: Hedge funds, pension funds, banks, and insurance companies
- Asset swap strategy: Valuing fixed-rate assets relative to LIBOR curve

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Mortgage Holders – To Hedge Convexity

Duration Profile

– OR –

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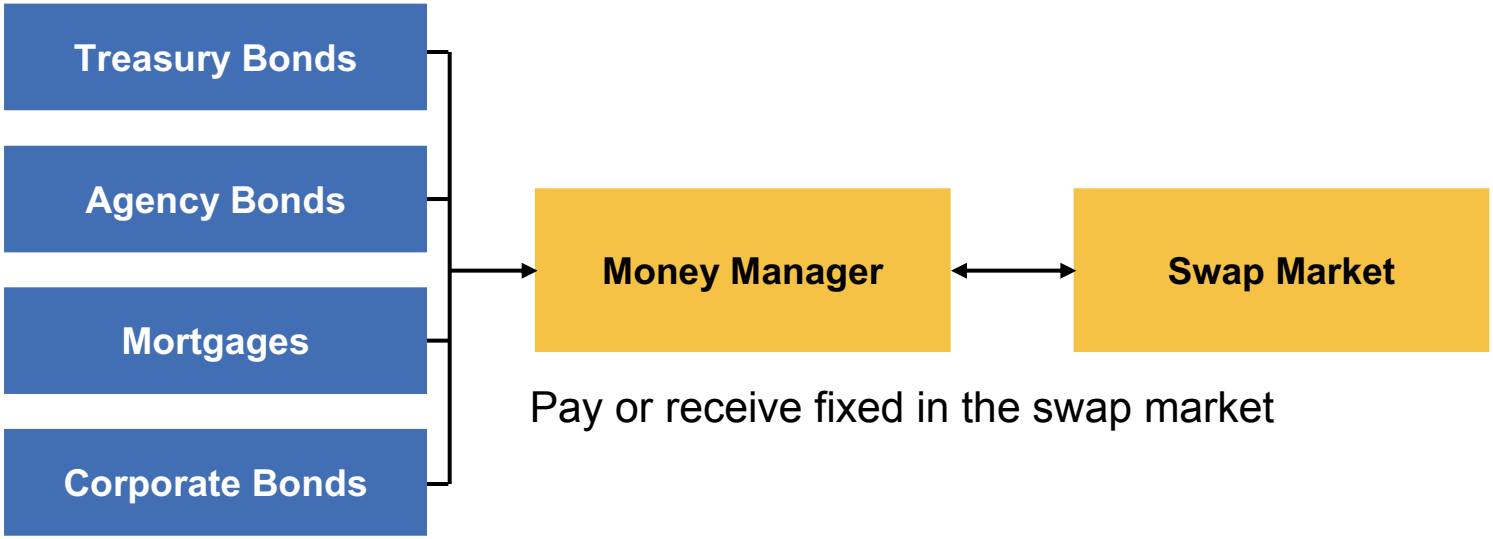
Money Managers – To Manage Portfolio Exposure



- Money Manager Transacts with the Swap Market to:
  - Increase and reduce spread exposure
  - Lengthen or shorten duration

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Interest Rate Swaps
The Swap Spread

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The Swap Spread

- Swap spread: The difference between the yield on a government security (such as a US Treasury) and the fixed rate of a floating swap (with the same maturity as the Treasury).

- What drives the swap spread?
  - Fundamental Factors:
    - Carry & Funding
    - Systematic risk
  - Technical factors
    - Treasury-specific factors
    - Supply/demand effect

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The Four Swap Spread Drivers

- **Carry/Funding effect**: if the difference between GC repo and 3mL were to permanently remain fixed at 25bp, the swap spread would also be 25bp. This effect is more pronounced in the short term.

- **Systematic Risk factor**: a market-wide credit squeeze would drive up 3mL, which would drive up the fixed rate on a swap and increase the swap spread.

- **Treasury-specific factors**: some individual Treasury bonds can be scarce and thus be funded at levels below GC repo.

- **Supply/Demand effect**: swaps are often a better hedging tool than Tsys as they also include systematic market risk. In times of crisis, for instance, the Treasury curve decouples from other assets since it is risk-free by definition.

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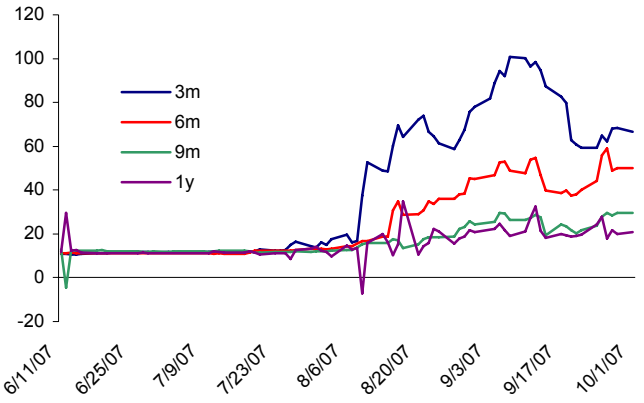
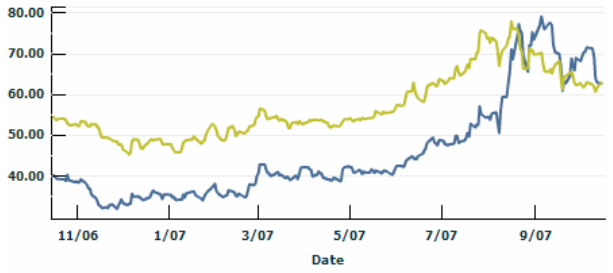
Funding Spreads Example – The Term Structure of Turmoil

- Stress in the asset-backed commercial paper market has pushed the 3M Libor / fed funds spread significantly wider
- The basis swap market is implying the spread will stay wide for the next 6-12 months.
- This has affected swap spread carry dramatically and has caused swap spreads to widen, especially 2y spreads

3m Libor / Fed Funds Fwd Spreads



2y and 10y Swap Spreads



	First	Last	Max	Min	Avg	StDev	ZScore	Periods
2y Spread	40.070	62.730	79.210	31.980	45.732	12.597	1.349	252
10y Spread	54.530	62.980	77.960	45.220	57.050	7.970	0.744	252

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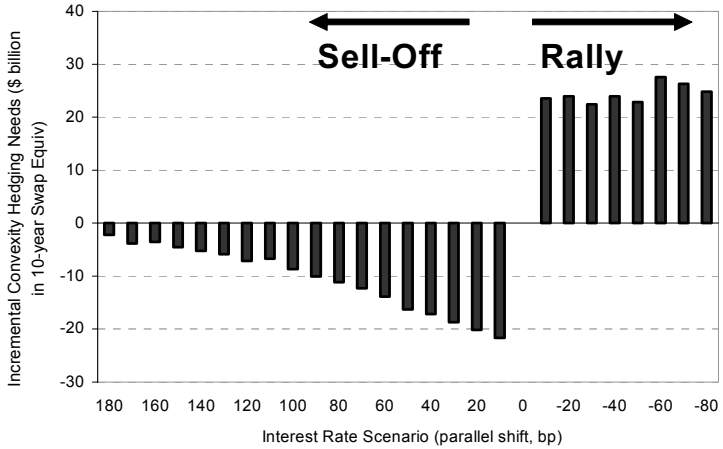
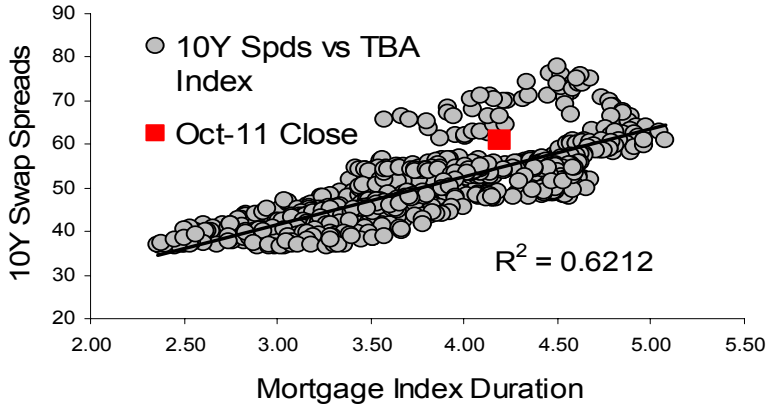
Supply / Demand Factor – Mortgage Convexity Hedging

Convexity Hedging Needs



Swap Spreads vs. Durations



- Since mortgage durations are volatile and the mortgage market is large, mortgage hedging needs are typically the most important driver of 10-year swap spreads.

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Roll and Carry Considerations

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Roll-Down & Carry – Definitions and Concepts

- Roll-Down & Carry comprise the entire PnL in an unchanged market
- Especially important in an environment of low volatility or low conviction
- Profit/Loss = Capital Gains + Interest Income

  = Δ(Price) from Market Volatility + Roll-Down + Pull-to-Par + Coupon - Funding

  ≈ Δ(Price) from Market Volatility + Roll-Down + Yield - Funding

  ≈ Δ(Price) from Market Volatility + Roll-Down + Carry

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Roll-Down & Carry – Calculations

Roll-Down

- Fully realized in a stable yield curve environment
- Example: 6M roll-down on a 10Y swap:

  Leveraged Perspective = 10Y Rate – 9.5Y Rate

  Total Return ≈ (10Y Rate – 9.5Y Rate) * (PV01 of a 9.5Y Swap)

Carry

- Can be locked in on trade date
- Example: 6M carry on a 10Y swap:

  $$\text{Leveraged Perspective} \approx \frac{\text{(10Y Rate)*(180/360) - (6M LIBOR)*(Act/360)}}{\text{(PV01 of a 9.5y Swap)}}$$

  Total Return = (10Y Rate)*(180/360) - (6M LIBOR)*(Act/360)

- Note that in a forward-starting swap, there is no carry (only roll-down)

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Quick Carry Estimations

• **Carry on spot rates (and hence forward rates) can be estimated very quickly using simple arithmetic:**

Example

Using only spot rates, what is the 3M carry on a duration neutral 2s10s flattener?

	(short)	*(long)*
	2yr leg	**10yr leg**
+ rate	4.852%	5.305%
- 3ML	5.214%	5.214%
= 1Y carry	- 36.4 bp	9.1 bp
→ 3M carry	- 9.1bps	2.23 bps
≈ Duration	1.887	7.735
Bp running	- 4.822 bps running	0.288 bps running

$$\text{bp running} = \frac{\text{carry}}{\text{swap duration}}$$

•Thus the approximate carry on a 2s10s flattener would be: 0.288 - (-4.822) = 5.11 bps running.

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Forward-Starting Swaps

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What Does the Forward Rate Represent?

- The forward rate/yields represents the breakeven future rate/yield on the bond versus investing in the short rate

- Example:
  - Spot 10-year Treasury yield = 4.6%
  - 3-month forward yield = 4.75%
  - Thus, if you buy the 10-year note rather than invest in 3-month cash, you will break even on the position (relative to the cash alternative) if the 10-year yield increases by 15 bp over the next three months

- Given that the LIBOR curve has a constant financing rate and is not impacted by idiosyncratic bond risk, it is easier to judge the shape of the forward curve in the swap market

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Expressing Views Using Forward Starting Swaps

- **If an investor has a time horizon that is greater than one day, he/she should be concerned with what is priced into the *forward* swap market rather than the *spot* market.**

- **For example:**

- **Suppose an investor believes that the 2-year swap rate is likely to decrease by 50 bp over the next year.**

- **Receiving on a 2-year swap does not express this view as the swap will be an 1-year instrument in one year's time.**

- **Thus, the investor needs to consider the 2-year rate one year forward.**

- **Note that if this rate is trading 100 bp lower than the spot 2-year rate, then the investor may in fact wish to pay on the forward rate - despite the fact he/she believes that 2-year rates will fall.**

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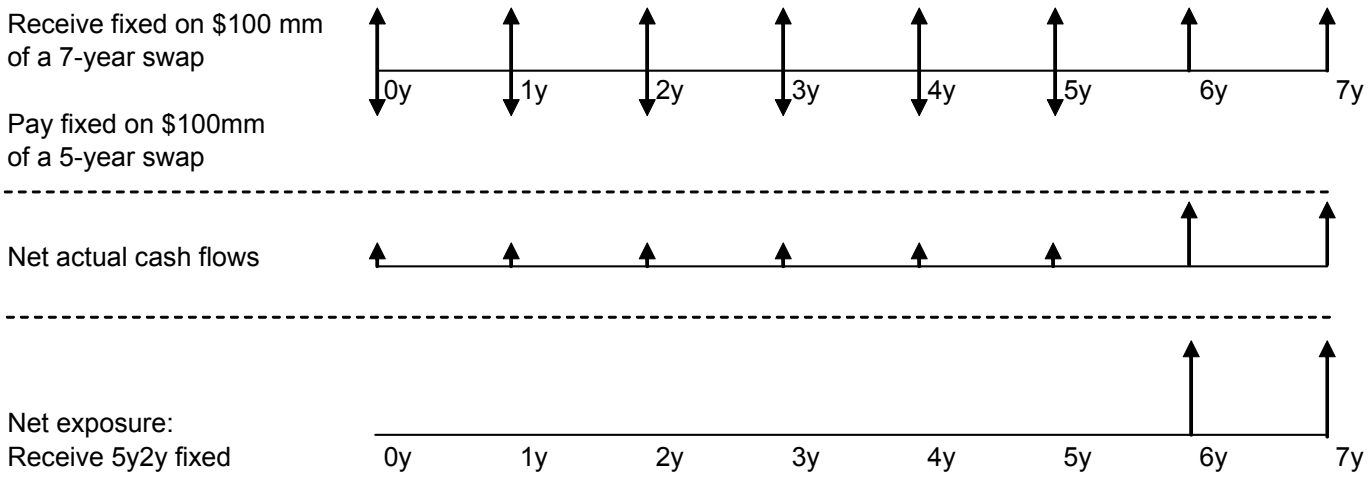
Forward-Starting Swaps: Cash Flows

A forward-starting swap = Combination of two spot-starting swaps

For example…

A 2-year swap 5-years forward is a combination of receiving on a 7-year swap and paying on a 5-year swap with equal notional amount



Note: floating rate components cancel each other out for the first five years

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Forward-Starting Swaps: Embedded Exposures

- **As combinations of two spot starting swaps, forward-starting swaps have embedded exposures that should be considered.**

- **For example, receiving on a 5y5y forward swap is equivalent to receiving the spot 10-year rate, while paying on the spot 5-year rate on equal notionals. This means the trade has both an outright exposure to the spot 10-year rate, but also has an embedded 5s/10s flattener**

Breaking down a 5y5y forward starting swap		Receive 10-year fixed	Pay 5-year fixed
Forward Starting Swap			
	Notional	100	100
	PV01 Risk	7.73	4.38
Forward Starting Swap Broken Down			
Duration Neutral Flattener	Notional	56.66	100
	PV01 Risk	4.38	4.38
Outright Long	Notional	43.34	
	PV01 Risk	3.35	

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Forward-Starting Swaps: Embedded Exposures

In general, forward rates move with the outright level of the market…

• The usual curve dynamics of bull steepening and bear flattening result in offsetting influences on forward rates: in a rally, forward rates fall with the spot rates, but the steepening puts upward pressure on the forward rates; vice-versa in a sell-off.

• These offsetting factors mean that we need to look at correlations between spot and forward rates to see how the exposures affect the forward rate:

Correlations since 1990

Rate 1	Rate 2	Beta	Correlation
10y	5y5y	0.95	89.93%
2y	1y1y	1.03	96.28%
5y	2y3y	0.95	91.24%
20y	10y10y	0.97	87.69%
30y	15y15y	0.73	81.32%
30y	10y20y	0.87	88.64%

Correlations since 2006

Rate 1	Rate 2	Beta	Correlation
10y	5y5y	0.78	86.65%
2y	1y1y	0.78	94.59%
5y	2y3y	0.81	90.71%
20y	10y10y	0.87	93.10%
30y	15y15y	0.92	97.53%
30y	10y20y	0.90	96.27%

For each 10 bp move in the 30-year rate, we expect around 9 bp of movement from the 10y20y rate (based on data from the past year)

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Example –
The Relationship Between Forward Rates and Carry

Suppose a client is interested in 2s/10s curve flattener - how can we quickly establish the roll-and-carry characteristics of a duration neutral 2s/10s flattener?

In \ For	Swap Tenor												
	01Y	02Y	03Y	04Y	05Y	06Y	07Y	08Y	09Y	10Y	15Y	20Y	25Y
Expiry 0M	4.97	4.79	4.83	4.91	5.00	5.06	5.12	5.17	5.22	5.26	5.40	5.47	5.49
1M	4.89	4.76	4.82	4.90	4.99	5.06	5.12	5.17	5.22	5.27	5.40	5.47	5.49
3M	4.77	4.72	4.80	4.90	4.99	5.06	5.12	5.18	5.22	5.27	5.41	5.47	5.49
6M	4.63	4.69	4.80	4.92	5.01	5.08	5.14	5.19	5.24	5.29	5.42	5.48	5.50
1Y	4.61	4.76	4.89	5.00	5.08	5.15	5.21	5.26	5.31	5.36	5.46	5.52	5.53
2Y	4.92	5.04	5.15	5.22	5.28	5.32	5.37	5.42	5.47	5.51	5.56	5.60	5.60
3Y	5.16	5.28	5.33	5.38	5.42	5.46	5.50	5.55	5.59	5.61	5.64	5.66	5.65
4Y	5.40	5.42	5.46	5.49	5.53	5.57	5.62	5.66	5.68	5.67	5.69	5.70	5.68
5Y	5.45	5.49	5.53	5.57	5.61	5.67	5.71	5.72	5.71	5.71	5.73	5.72	5.70
7Y	5.61	5.65	5.71	5.77	5.81	5.81	5.79	5.78	5.77	5.77	5.78	5.75	5.72
10Y	5.99	6.00	5.94	5.88	5.83	5.81	5.81	5.81	5.82	5.82	5.79	5.74	5.70
15Y	5.70	5.75	5.78	5.80	5.81	5.81	5.80	5.79	5.77	5.76	5.69	5.64	5.60
20Y	5.80	5.76	5.73	5.70	5.68	5.66	5.65	5.63	5.62	5.60	5.54	5.50	5.48

We know that for the 10-year rate (for example):

- 3m Roll-down = 10y Rate - 9.75y Rate
- 3m Carry = 9.75y Rate 3m Forward - 10y Rate

Hence:

- 3m Roll and Carry = 10y Rate - 9.75y Rate
  + (9.75y Rate 3m Forward - 10y Rate)
  = 9.75y Rate 3m Forward - 9.75y Rate

Similarly:

10y Rate 3m Forward - 10y Spot Rate
= Roll and Carry on 10.25Rate

So: 3m Forward 2s/10s curve - Spot 2s/10s curve = (10y Rate 3m Fwd - 2y Rate 3m Fwd) - (Spot 10y Rate - Spot 2y Rate)

= (10y Rate 3m Fwd - Spot 10y Rate) - (2y Rate 3m Fwd - Spot 2y Rate)

= Roll and Carry on 10.25 Rate - Roll and Carry on 2.25 Rate

= Roll and Carry on a Duration Neutral 2.25y/10.25y Flattener

≈ Roll and Carry on a Duration Neutral 2s/10s Flattener

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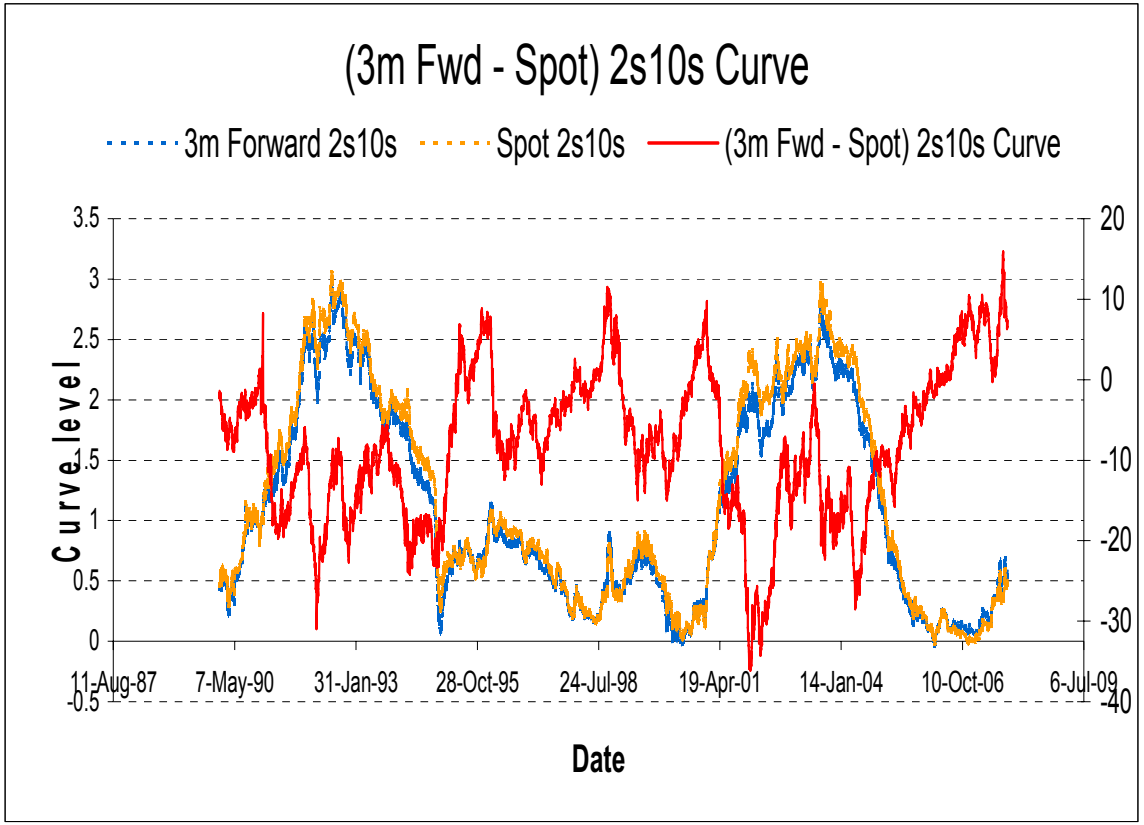
Approximation Can be Used to Understand Roll and Carry

Such valuation techniques can be used to look at roll and carry over history...



- Plotting the historical difference between the 2s/10s curve 3 months forward and the spot 2s/10s curve gives an idea of the level of roll-and-carry offered in the past.
- Recent steepening of the forward curve has led to relatively high levels of roll-and-carry for flattening trades.

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Convexity Issues (I)

When looking further out on the forward curve, convexity issues need to be kept in mind...

In \ For		Swap Tenor													2s10s bps
		01Y	02Y	03Y	04Y	05Y	06Y	07Y	08Y	09Y	10Y	15Y	20Y	25Y	
Expiry	0M	4.97	4.79	4.83	4.91	5.00	5.06	5.12	5.17	5.22	5.26	5.40	5.47	5.49	47.1
	1M	4.89	4.76	4.82	4.90	4.99	5.06	5.12	5.17	5.22	5.27	5.40	5.47	5.49	50.6
	3M	4.77	4.72	4.80	4.90	4.99	5.06	5.12	5.18	5.22	5.27	5.41	5.47	5.49	55.3
	6M	4.63	4.69	4.80	4.92	5.01	5.08	5.14	5.19	5.24	5.29	5.42	5.48	5.50	60.2
	1Y	4.61	4.76	4.89	5.00	5.08	5.15	5.21	5.26	5.31	5.36	5.46	5.52	5.53	60.0
	2Y	4.92	5.04	5.15	5.22	5.28	5.32	5.37	5.42	5.47	5.51	5.56	5.60	5.60	47.2
	3Y	5.16	5.28	5.33	5.38	5.42	5.46	5.50	5.55	5.59	5.61	5.64	5.66	5.65	33.5
	4Y	5.40	5.42	5.46	5.49	5.53	5.57	5.62	5.66	5.68	5.67	5.69	5.70	5.68	25.3
	5Y	5.45	5.49	5.53	5.57	5.61	5.67	5.71	5.72	5.71	5.71	5.73	5.72	5.70	21.4
	7Y	5.61	5.65	5.71	5.77	5.81	5.81	5.79	5.78	5.77	5.77	5.78	5.75	5.72	11.7
	10Y	5.99	6.00	5.94	5.88	5.83	5.81	5.81	5.81	5.82	5.82	5.79	5.74	5.70	-17.6
	15Y	5.70	5.75	5.78	5.80	5.81	5.81	5.80	5.79	5.77	5.76	5.69	5.64	5.60	0.9
	20Y	5.80	5.76	5.73	5.70	5.68	5.66	5.65	5.63	5.62	5.60	5.54	5.50	5.48	-16.1

- Is the market really pricing inversion of the 10s/30s curve in 7 years' time?
- No: the curve has greater convexity in the 30-year sector...

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Convexity Issues (II)

- **Consider a duration neutral 10s/30s flattener 10 years forward.**
- **Differences in convexity mean that as the market moves, re-hedging is required to remain duration neutral...**

		Rate (%)	PV01	Notional (mm)	Risk
Pay	10y10y	5.75	4.85	190.91	9.26
Receive	10y30y	5.60	9.26	100	9.26

Initially, the trade is set up to be duration neutral.

↓ Market rallies - yield curve falls 100 bp in parallel

		Rate (%)	PV01	Notional (mm)	Risk
Pay	10y10y	4.75	5.64	190.91	10.77
Receive	10y30y	4.60	11.57	100	11.57

As the market rallies, higher convexity means the duration on the 10y30y rate increases more, leaving the trade needing re-hedging to make it market directional again. The investor therefore has to pay on around $ 7 mm 10y30y at 4.60%

↓ Market sells-off - yield curve rises 200 bp in parallel

		Rate (%)	PV01	Notional (mm)	Risk
Pay	10y10y	6.75	4.18	190.91	7.98
Receive	10y30y	6.60	7.47	93.06	6.95

Similarly, when the market sells off the duration of the 10y30y falls faster, and now the investor needs to receive on around $ 14 mm 10y30 at 6.60% to re-hedge.

↓ Market rallies back to original level of yields

		Rate (%)	PV01	Notional (mm)	Risk
Pay	10y10y	5.75	4.85	190.91	9.26
Receive	10y30y	5.60	9.26	106.8	9.89

As the market rallies back to the original level, a final hedge of paying around $ 7 mm of 10y30y at 5.60% is required.

So what has happened?

The market has returned to the original levels, suggesting the flattener has had zero P&L - however, during the hedging, the investor has paid at 4.60% and received at 6.60% and 5.60% resulting in profit. This is due to being long convexity, and so the forward curve demands a premium for this privilege - hence, the 10y30y rate is lower and the forward curve is inverted.

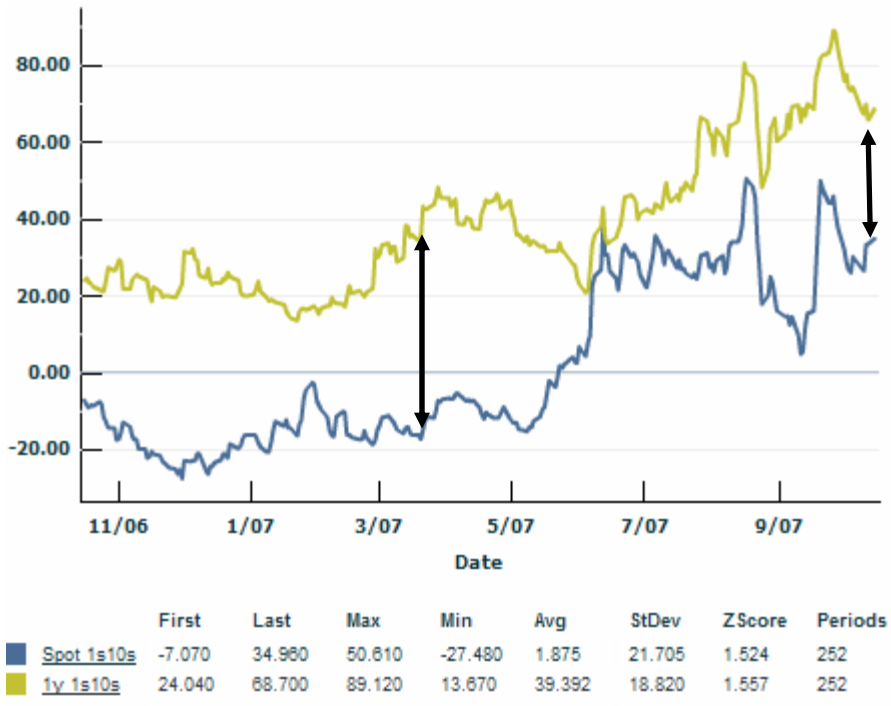
See additional important disclosures at the end of this report.

Significance Ratio – Volatility Adjusted Carry

- Significance Ratio = [Rolldown & Carry] / Volatility
- A metric to find good risk / reward carry trades.

Levels on 3/15/2007	
Spot 1s10s	-15 bp
1y Fwd 1s10s	35 bp
Rolldown	50 bp
3m Realized Volatility	27.2
Sig Ratio	1.9

Levels on 10/15/2007	
Spot 1s10s	35 bp
1y Fwd 1s10s	65 bp
Rolldown	30 bp
3m Realized Volatility	54.2
Sig Ratio	0.5



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Morgan Stanley Forward Grid

	1y		2y		3y	
00M	4.951		4.828		4.880	
	32%		45%		48%	
	-1.8	-45.7%	-2.3	-15.0%	-2.2	-5.4%
01M	4.872	-7.9	4.798	-3.0	4.866	-1.4
	44%	63%	48%	61%	52%	56%
	-2.7	-9.8%	-2.8	2.9%	-2.4	5.1%
03M	4.771	-18.0	4.771	-5.7	4.860	-2.0
	50%	69%	52%	71%	55%	71%
	-2.5	-4.7%	-2.5	4.9%	-2.3	5.7%
06M	4.679	-27.2	4.762	-6.6	4.872	-0.8
	53%	66%	55%	69%	53%	68%
	-2.7	-3.2%	-2.5	4.0%	-2.3	4.5%

- Black Cell if percentile for the rate is greater than 1 standard deviation ; Grey Cell if percentile for the rate is less than / equal to -1 standard deviation.

- ▲ if percentile for spread from spot is greater than 1 standard deviation ;▼ if percentile for spread from spot is less than / equal to -1 standard deviation.

- Green if value is less than zero ; Red if value is greater than zero.

Key

Current rate	4.872 ▲ -7.9	Spread from Spot
3m Percentile*	44% 63%	3m Percentile for spread from spot
One Day Change	-2.7 -9.8%	3m Roll and Carry / 3m Volatility

* 3m Percentile - Over 3m period, percentage of days where value was less than today's value

Source: Morgan Stanley

See additional important disclosures at the end of this report.

The Details of Asset Swapping

See additional important disclosures at the end of this report.

Yield/Yield Asset Swap

The focus on simplicity

- On a long swap spread position, the investor simply purchases a bond and pays fixed on a swap to the maturity of the bond, duration weighted

- The yield/yield asset swap spread is simply the difference between the yield-to-maturity of the bond and the par swap rate to the maturity of the bond

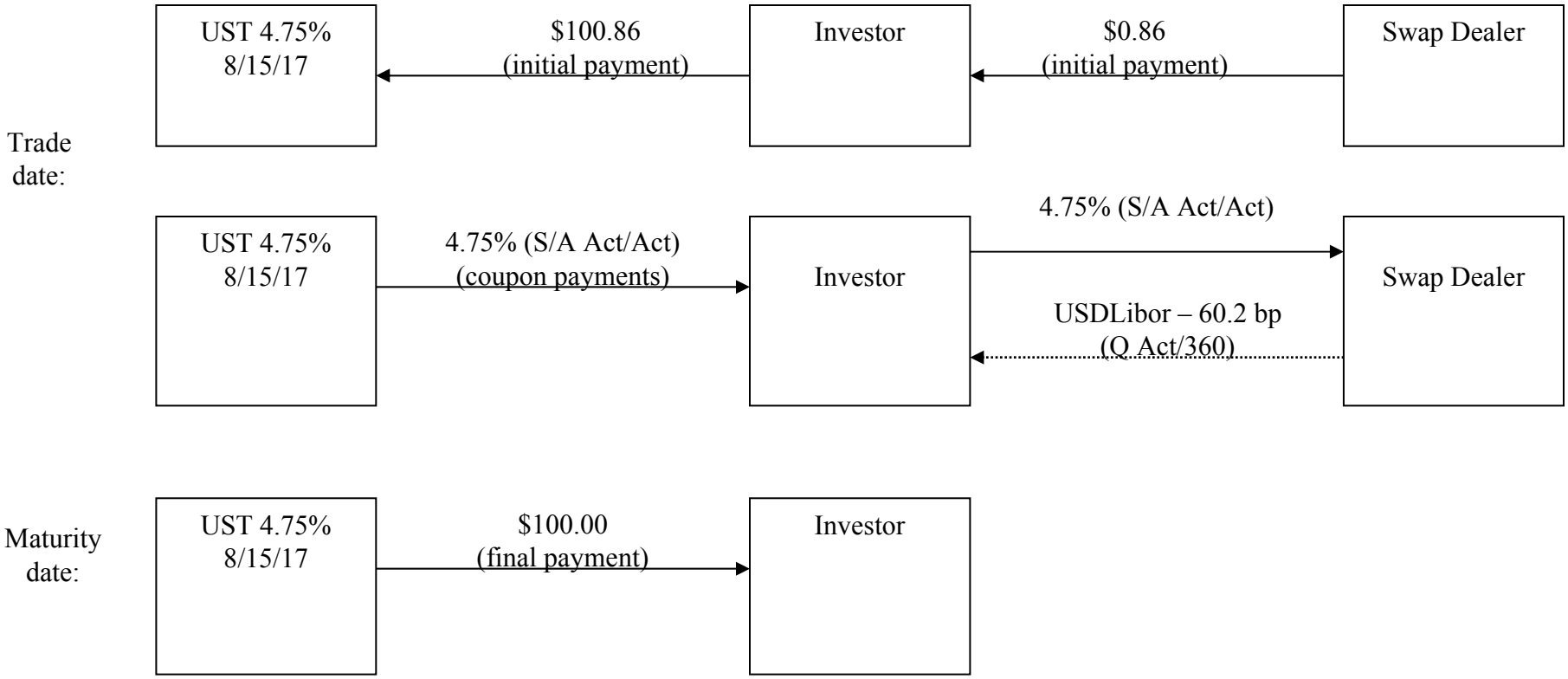
- Example (10/16/07 trade date)

  - Investor buys $100mm UST 8/17 at a yield of 4.75%
  - Investor pays 5.252% on a $101.2mm of a swap from 10/18/02 to 8/15/17
  - Yield/yield swap spread: 60.2 bp (5.252% - 4.650%)
  - DV01 of the bond: 7.862
  - DV01 of the fixed leg of the swap: 7.769
  - Hedge ratio: 1.012

See additional important disclosures at the end of this report.

Par/Par Asset Swap Methodology

Upfront Exchange of $$ to Bring the Bond to Par



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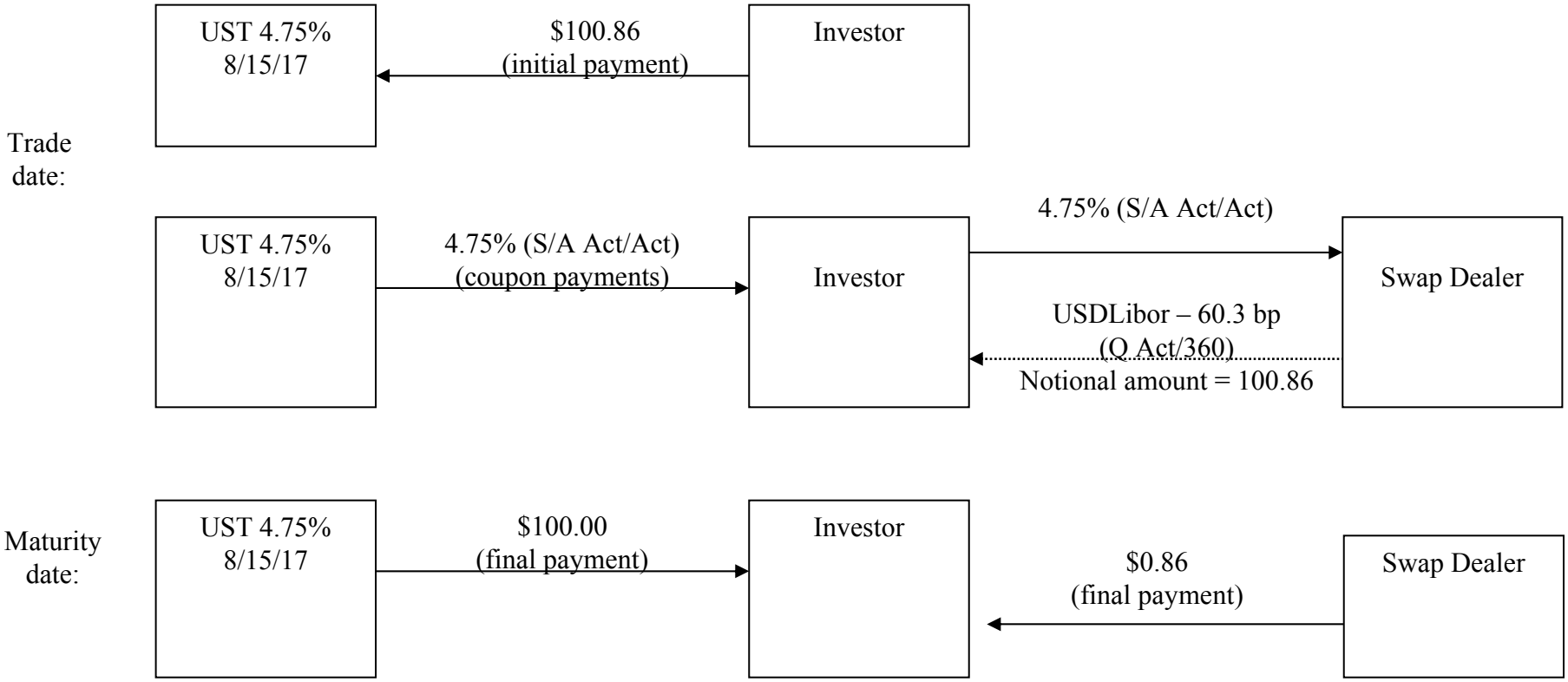
MVA Asset Swap Methodology

Final exchange and change of floating notional to bring the bond to par



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Other Methods to Note

- Main issue: How to cope with a bond that does not trade at par
  - Premium/discount can be amortized over time according in different ways
    - Linear
    - Constant bond yield (yield accrete)
- Theoretical LIBOR OAS
  - Shifting LIBOR forwards to discount the bond's cashflows back to the price of the bond
  - Theoretical notion, not able to trade

See additional important disclosures at the end of this report.

Summary Matrix

	•***Par/Par***	•***MVA***	•***Yield/Yield***
•**Pros**	•Brings all bonds back to par •Best for comparing bonds with volatility exposure •Relatively constant spread duration	•True match of cash flows - notional on LIBOR leg is equal to repo notional •Compare directly to repo/LIBOR spread •No collateral/credit issues on day one	•Ease of execution •Market standard •Easy to monitor and value
•**Cons**	•Large upfront payment creates credit/collateral issues •Financing assumption for the upfront payment •Execution	•LIBOR financing assumption on the final payment •Trade effectively embeds a LIBOR based loan •Spread duration not constant (too many changing parts) •Execution	•Convexity risk - trade is duration weighted, not convexity weighted. •Implied curve risk for bonds with off-market coupons •Carry estimation for bonds not trading close to par

See additional important disclosures at the end of this report.

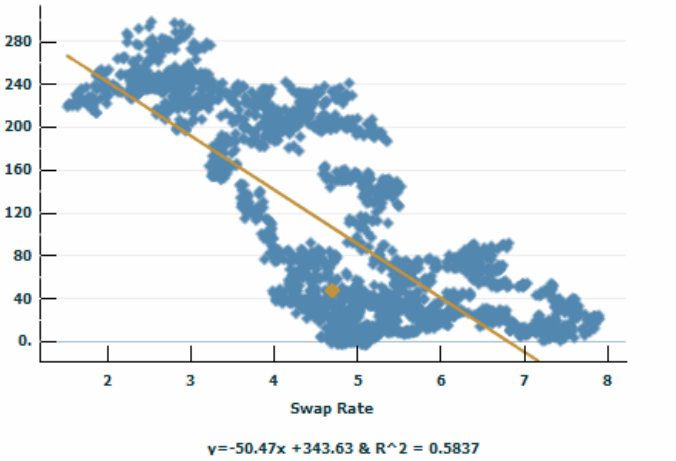
Other Topics

Swap Market Correlations to Be Aware of...

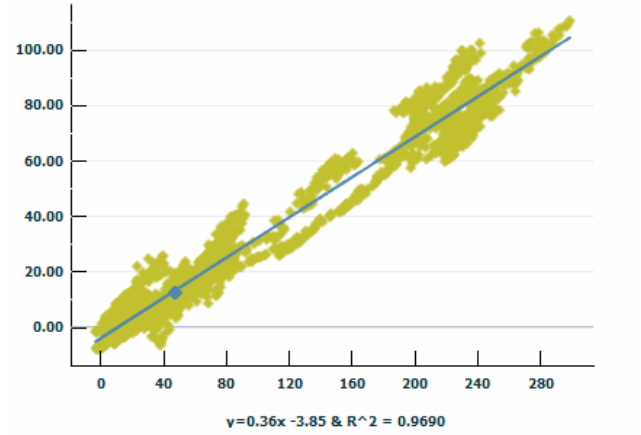
Most swap curve trades and many butterfly trades have a high degree of market directionality which should always be kept in mind when considering such trades. The correlations are useful guides in relative value analysis - it should always be remembered, however, that they can break down and reasons for such breakdowns are usually of interest.

The following graphs highlight a few such correlations...

USD 2s10s vs 1y1y Rate



USD 50/50 2s10s30 Fly vs 2s10s Curve



In general, the yield curve steepens in rallies and flattens in sell-offs as central bank movement leads the way.

In general the 2s10s curve is more volatile than the 10s30s curve, so the belly of the 2s10s30s fly tends to cheapen when the 2s10s curve steepens

Butterfly Trades - Risk Weighting Methodologies

Trading one curve against another
Risk weightings can be developed in several ways.

Simple Butterfly (50/50 Risk Weighted)

Butterfly Level quoted as 1 x 5y rate – 0.5 x 2y rate – 0.5 x 10y rate

Risk distributed equally on each wing.

Volatility-adjusted Butterfly

Risk assigned according to volatility of the curves involved in the butterfly.

Accounts for relative volatilities but not correlations.

Regression Weighted Butterfly

Regress one curve in the butterfly against the other and determine the hedge ratio based on the beta of the regression.

Regressions are not symmetrical. The hedge ratio is dependent on which curve is chosen as the independent variable.

PCA Weighted Butterfly

Principal component analysis – Decomposes the covariance matrix between points on the yield curve into orthogonal eigenvectors

Weight trades to minimize exposure to the 2 eigenvectors that explain 99% of curve movements.

Accounts for correlations and relative volatilities, and results are symmetrical.

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PCA or Regression

- Hedging 10-year rate with 5-year rate
  - Regression 10Y changes on 5Y changes results in different hedge ratios than regressing 5Y changes on 10Y changes – conditional analysis
  - PCA does not have this problem – unconditional analysis
- Rich-Cheap detection
  - Regression is time consuming as you would need regressions of 1s/5s, 2s/10s, 2s/5s/10s, 1s/3s/7s, 1s/4s/8s, 5s/7s/10s etc. to accomplish what PCA does
- PCA isolates direction, slope and curvature movements whereas this is difficult to do with regression
  - Hence, PCA can isolate a trade's exposure to curvature net of direction and slope

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Morgan Stanley PCA Report

Butterfly	DV01 Weights[1]		Belly 100MM Par		Current	Lifetime[2]				60 Days				Roll Down[3]	Carry[3]
	Left	Right	Left	Right		Average	Std Dev	Z-Score	R/C	Average	Std Dev	Z-Score	R/C		
1s2s3s	0.41	0.61	79.5	42.0	-19.66	-14.15	4.26	-1.29	R	-19.40	1.10	-0.24		-5.35	-1.04
1s3s5s	0.36	0.68	101.9	42.7	-30.83	-22.75	8.52	-0.95		-31.02	1.53	0.13		-9.20	-3.12
1s5s10s	0.27	0.78	123.5	44.2	-48.36	-40.57	9.24	-0.84		-48.17	2.75	-0.07		-8.25	-3.77
1s7s15s	0.21	0.87	129.0	49.4	-63.50	-60.61	9.27	-0.31		-64.21	2.40	0.30		-7.40	-3.71

- The PCA weights are determined using data since January 01, 1993
- The lifetime of the butterfly is determined from data since Jan 01 1993

- Rolldown and Carry assume as 6M investment horizon

- An investor who is long a butterfly is positioned for the level to fall. Roll and Carry are computed to agree with this. That is, a negative value for carry or rolldown works in favor of a long butterfly.

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Morgan Stanley Quotient – Historical Data & Basic Analytics

See additional important disclosures at the end of this report.

Follow Up

Please do not hesitate to contact us if you have any further questions:

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