

# Teach-in: Interest Rate Swaps and Options

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Morgan Stanley University

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## Agenda

- **Interest Rate Swap Review**
- **Trading Strategies**
- **Roll and Carry Considerations**
- **Interest Rate Options: Swaptions**
- **Drivers of Volatility**

**By the end of this class you will be able to:**

- **Use swap duration and convexity to measure your risk and determine your exposure**
- **Explain the uses of Interest Rate Options, who uses them and why**
- **Converse with your clients about various trading strategies they can execute using Interest Rate Derivatives, including duration, curve, swap spread, forward, and butterfly strategies**



## Swaps Review

# Review: What is a Swap?

Let's not forget what we discussed in our first swap presentation

- In the most basic sense, a swap is a par bond financed in Libor:
  - A long position in a swap is equivalent to a levered long position in a cash bond
- Throughout this presentation there are a couple of things to keep straight in your mind:
  - Positioning is relative to what one is doing on the fixed leg
  - LONG THE MARKET = RECEIVING FIXED ON A SWAP
  - SHORT THE MARKET = PAYING FIXED ON A SWAP

rates rally,  
R↓



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MS sell = receive fixed (?)

## Parties of the Interest Rate Swap

### Party A: Fixed Rate Payer

- Pays Fixed
- Receives Floating
- Like selling the bond market
  - Loses if rates fall
  - Wins if rates rise
- Has established the price sensitivities of a longer term liability and a floating rate asset

### Party B: Fixed Rate Receiver

- Receives Fixed = Long the market
- Pays Floating = long swap.
- Like buying the bond market
  - Wins if rates fall = long cash bond
  - Loses if rates rise
- Has established the price sensitivities of a longer term asset and a floating rate liability = wins if rates rally

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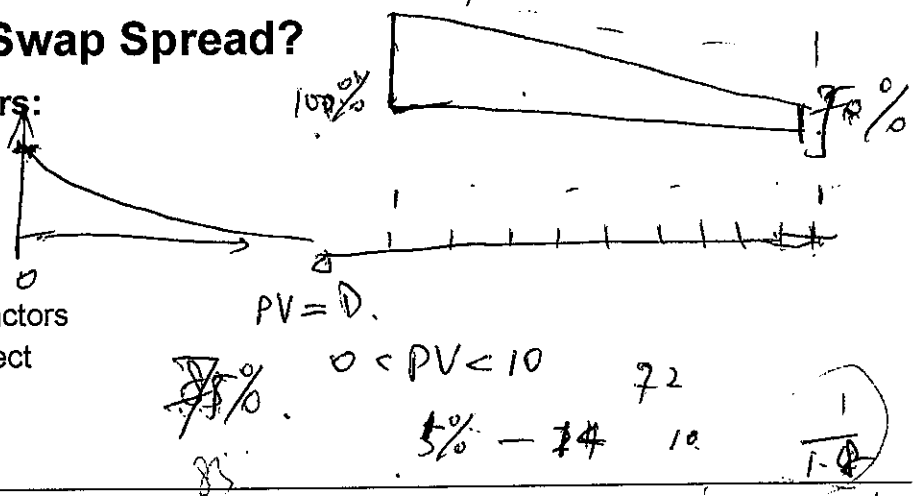
# Swap Quoted as Swap Spread

## • Swap Spread is the difference between:

- The yield on a government security (such as a US Treasury)
- 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



# Duration Example

- 2y Swap, with \$100mm Notional
  - DV01 = 1.9
  - DV01 = \$100mm \* 1.9 / 10,000
  - DV01 = \$19,000 per bp
- 10y Swap, with \$100mm Notional
  - DV01 = 8.1
  - DV01 = \$100mm \* 8.1 / 10,000
  - DV01 = \$81,000 per bp
- Duration Neutral Curve Trade
  - 2y DV01 = \$426mm \* 1.9 / 10000 = \$81,000 per bp
  - 10y DV01 = \$100mm \* 8.1 / 10000 = \$81,000 per bp

*Duration*  
*10y*

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*PV01*

# Convexity Example

- 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

*pay 10y receive 30y*

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

*10y 30y bond convexity*

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

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

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

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

- As market rallies, higher convexity means the duration on the 10y30y rate increases, leaving the trade to be re-hedged to make it market directional again

- The investor therefore has to pay on around \$ 7 mm 10y30y at 4.60%

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

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

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*long convexity*

*hedge m10y30y to profit?*

# Convexity Example

- **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

## Trade Strategies:

Outright Swap  
Curve Trade  
Curve Cap  
Butterfly  
Fwd Starting  
Yield/Yield Asset Swap

# Outright Trade - Execution Example

- A typical IRS inquiry would sound like this:

**Account A:** Thanks again for sending that chart over. I agree yields are going higher, let's **short** the market here.

**MS Salesperson:** No problem. Let me get a level. (calls Mike Barletta, Mike Jesionowski or Tanuj Kana on the trading desk)... "Tanuj, where can Account A, **pay** on 100mm 10yrs outright?"

**Tanuj:** Mid right now is 4.615%, you client can **pay** 4.62% on 100mm outright

**MS Salesperson:** (to Account A) You can **pay** 4.62%

**Account A:** That's done. I **pay** 100mm 10yr rates at 4.62%. What's my dv01?

**MS Salesperson:** (to Tanuj) Tanuj you're done. Account A **pays**, you **receive** on 100m @ 4.62%.

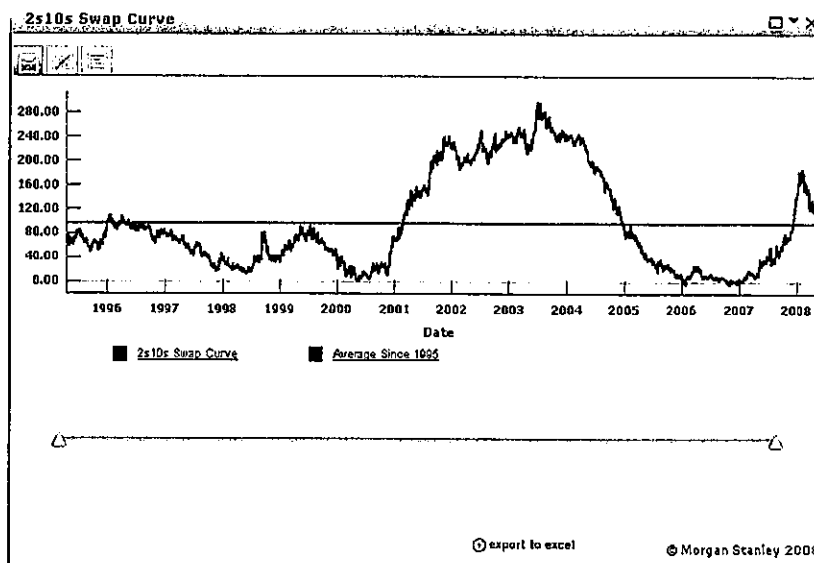
(to Account A) I see your **short** approximately \$80,800/bp of 10yrs. Thanks for the trade.

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## Curve Trade - Overview

- Many of Morgan Stanley's clients use Interest Rate Swaps to **hedge** positions and to **speculate** in the rates market
- Use **msq** to see that yield movement
- Accounts looking to **speculate** in the market may bet on long end yields going higher relative to front end yields



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# Curve Trade - Details

## • Steepener

- Receive on short maturity swap, pay on long maturity swap
- Duration neutral

## • Flattener

- Pay on short maturity swap, receive on long maturity swap
- Duration neutral

## • Example

- Receive on \$426mm 2y swap @ 3.33%
- Pay on \$100mm 10y swaps @ 4.56%

$$2y \text{ DV01} = \$426\text{mm} * 1.9 / 10000 = \$81,000 \text{ per bp (long)}$$

$$10y \text{ DV01} = \$100\text{mm} * 8.1 / 10000 = \$81,000 \text{ per bp (short)}$$

- If 2y rates rally 20 bp and 10y rates rally 10 bp, gain on the trade will be:

$$\$81,000 / \text{bp} * 20 - \$81,000 / \text{bp} * 10 = \$810,000$$

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# Curve Trade - Execution Example

## • A typical IRS inquiry would sound like this:

**Account A:** Thanks again for sending that chart over. I agree with your argument that the curve should re-steepen from current levels. Where can I put on 25k/01 of 2s10s curve. I pay on the curve.

**MS Salesperson:** No problem. Let me get a level. (calls Mike Barletta, Mike Jesionowski or Tanuj Kana on the trading desk)... "Tanuj, where can Account A, pay on 25k/01 of the 2s10s curve. Account pays 10s and receives 2s.?"

**Tanuj:** Mid right now is 123bps, your client can enter the steepener at 123.5bps

**MS Salesperson:** (to Account A) You can pay 123.5bps

**Account A:** That's done. I pay on 25k/01 of the 2s10s curve at 123.5

**MS Salesperson:** (to Tanuj) Tanuj you're done. Account A pays, you receive on 25k/01 @ 123.5bps.

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# CMS Forwards & Options

- CMS (constant maturity swap) forwards and options provide a payout based on swap rates
- Allow investors to express rate & curve views without worrying about managing DV01 & convexity exposure of underlying swaps
- Convexity Adjustment
  - Difference between CMS forward rate and traditional forward swap rate
  - Accounts for value of convexity difference between a CMS forward and forward swap

## Example: 1y 2s10s Curve Cap

### INDICATIVE TRADE TERMS:

Notional Amount:	USD 1,000,000,000
Option Buyer:	Client
Expiration Date:	May 30, 2009 (1 year)
Strike:	0.85% (85bp)
Reference Index:	10-year swap rate minus 2-year swap rate
Premium:	30 bps (\$3,000,000)

- The breakeven on the trade is 115bps
- Spot curve is 123bps
- The client's maximum loss on the trade is limited to the option premium of 30bps

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## 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  $1 \times 5y \text{ rate} - 0.5 \times 2y \text{ rate} - 0.5 \times 10y \text{ rate}$
- 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

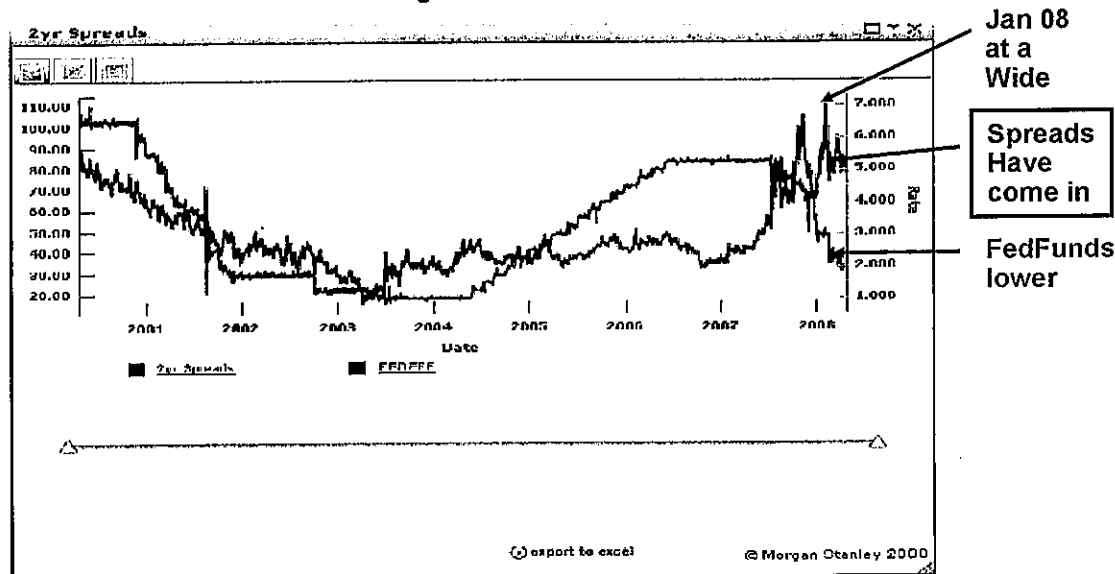
- Principal component analysis – Decomposes the covariance matrix between points on the yield curve into orthogonal eigenvectors
- Weight trades to minimize exposure to the 2 eigenvectors that explain 99% of curve movements.
- Accounts for correlations and relative volatilities, and results are symmetrical.

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## 2 Year Spread Trade - Overview

- 2yr spreads between Treasury and Fed Funds have come in from wide levels seen in January, but are **still at historic wides**, especially given what the Fed has done lowering rates over the last 2 months



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## 2 Year Spread Trade - Details

- Spread widener (long spreads) – *Long treasury*  
 – Buy on-the-run Treasury / Pay Fixed on benchmark Swap *receive floating*
- Spread tightener (short spreads) – *pay floating*  
 – Short on-the-run Treasury / Receive Fixed on Swaps *Short 2y T bond*

### Example:

2y Spread Tightener @ 80.5 bp

- Receive \$1.0B on 2y swap *benchmark swap*
  - Effective: 5/30/2008
  - Maturity: 5/30/2010
  - Rate 3.23%
  - DV01:  $\$1.0B \times 1.92/10,000 = \$192,000$

- Short \$1.032Bm 2y USTs
  - Settle: 5/30/2008
  - Maturity: 4/30/2010
  - Yield: 2.425%
  - DV01:  $\$1.032B \times 1.86/10,000 = \$192,000$

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## 2y Swap Spread Trade – Execution Example

- A typical inquiry would sound like this:

**Account A:** I really think all of the recent actions by the Fed is going to have an impact on the credit crisis. I think Libor should start to come in as banks start lending to one another. Where can I sell some 2yr spreads – \$192k/bp. tightener

**MS Salesperson:** Got it. Let me get a level from Tanuj. (to Tanuj) "Where can account A receive on \$1bln 2yr spreads – he sells 2yr spreads?" spread ↓

**Tanuj:** Bid side on 2yr spreads is 80.5 right now. receive benchmark fixed

**MS Salesperson:** (to Account A) You can sell \$1bln which is \$192k/bp at 80.5. You receive 2yr swaps vs selling 2yr treasuries at a spread of 80.5bps. receive fix

**Account A:** That is done. Thank you.

**MS Salesperson:** (to Tanuj) Done.

(to Account A) Done. Thanks for the trade.

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↑ Treasury yield ↑ swap pay  
↓ yield ↓ swap rate

## Yield/Yield Asset Swap

### The focus on simplicity

- On a long swap <sup>short the market</sup> spread position, the investor simply purchases a bond and <sup>pay fix receive floating</sup> pays fixed on a swap to the maturity of the bond, duration weighted short a swap
- 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
- Yield/Yield Spreads are typically used to hedge or take RV trades among specific bonds

# Yield/Yield Asset Swap Example

- **05/28/2008 Trade Date**

- Investor buys \$100mm UST 4.75 8/17 at a yield of 3.830%
- Investor enters into a Swap where they pay 4.392% (swap rate) on a \$102.5mm from 5/30/2008 to 8/15/17

- **Yield/yield swap spread equals:**

- $4.392\% - 3.830\% = 56.9 \text{ bp}$

- **Hedge ratio equals:**

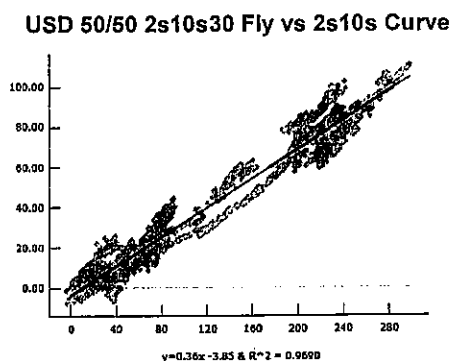
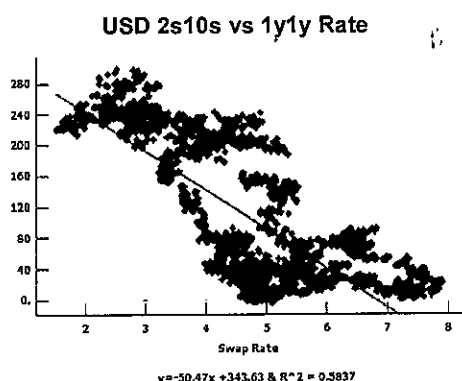
- DV01 of the bond: 7.77
- DV01 of the fixed leg of the swap: 7.577
- 7.77 divided by 7.577 = **1.025**

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## 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



**In general:**

- The yield curve steepens in rallies and flattens in sell-offs as central bank movement leads the way
- 2s10s curve is more volatile than the 10s30s curve, so the belly of the 2s10s30s fly tends to cheapen when the 2s10s curve steepens

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↑  
receive 2s fix buy  
pay 10s fix short

short leg

belly  
2 10 30  
↑ ↓  
? wings

# 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**
  - =  $\Delta(\text{Price})$  from Market Volatility + Roll-Down + *Pull-to-Par* + *Coupon* - *Funding*
  - $\approx \Delta(\text{Price})$  from Market Volatility + Roll-Down + *Yield* - *Funding*
  - $\approx \Delta(\text{Price})$  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:

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

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

Forward rates are determined by carry.

Difference between 10y and 6m 9.5y forward rate is equal to the carry

Note: In a forward-starting swap, there is no carry, only roll-down

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receive 4.8% pay 4.5% 26

# Trading Forward-Starting Swaps

- A forward-starting swap = Combination of two spot-starting swaps
- Allows investor to lock in carry to a specific date

Example: A 5-year swap 2-years forward is a combination of:

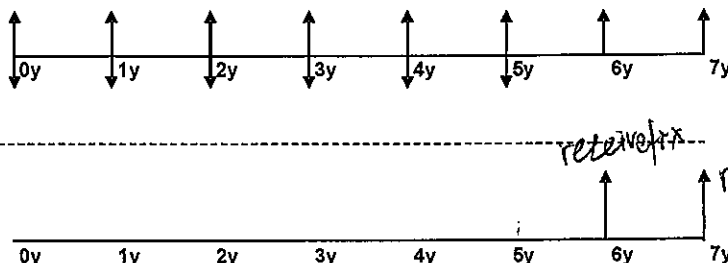
- Receiving on a 7-year swap
- Paying on a 5-year swap with equal notional amount

Receive fixed on \$100 mm of a 7-year swap

Pay fixed on \$100mm of a 5-year swap

Net exposure:

Receive 5y2y fixed

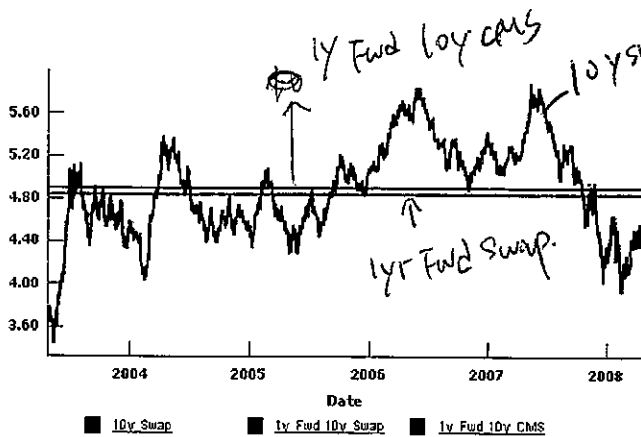


5-year 2y receive fixed for 2 years.

Floating rate components cancel each other out for the first five years, leaving you with the 2yr swap 5yrs forward

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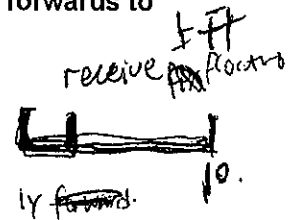
# Forward Swap Example



## Potential Mean Reversion Trade:

- 10y Swaps are low historically (4.56%)
- Can I bet on reversion to 4.88% 5y average?
- Ability to make money on this view depends on rolldown & carry to horizon
- 1y fwd 10y rate is 4.84%, CMS is 4.90%.
- Market priced for mean reversion in 1y 1y to 10y rate
- 10y swap rate needs be above forwards to profit on this view

If your Horizon > 1d you are trading forward rates



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6m 9.5y

10y

6m 9.5y

27.5%

2.5y

7.7%

pay 1 year floating  
receive 1 year

pay 10y fix receive 1y floating  
receive 1y fix receive 1y floating  
pay 10y fix

receive 7.5% pay 7.7%  
(expect 6m 7.5%)  
however 7.7% 3.5% pay 9.5%  
@ 7.7%  
3 0.5% → PV = ...

positive rolldown ✓  
negative : 10y curve 7.7%  
7.7%

0 : curve 7.7% 7.7%

## Swaptions

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# The Volatility Products

- **Exchange Traded Options**

- Chicago Board of Trade (CBOT)
- Chicago Mercantile Exchange (CME)
- Options on Treasury futures and Eurodollar futures
- Defined option types and expiries
  - Most are American
  - Most options expire in 1 to 1.5 years or less

- **Over-The-Counter (OTC) Options**

- Options on Treasuries
- Options on bullet agencies
- Options on swap rates
- Wide variety of option types. Ability to customize the option to fit the investor's particular trading or hedging needs

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## Exchange Traded Options

- **CBOT (Chicago Board of Trade)**

- Short dated options on bond futures
- Expiries out to 6 months on 2-year, 5-year, 10-year, and 30-year futures
- Actively traded by speculators and hedgers

- **CME (Chicago Mercantile Exchange)**

- Short dated options on Eurodollar futures
- Expiries out to 2-years on Eurodollar futures (Futures out to 10-years)

- **Exchanges:**

- Provide good indications of option levels (Bloomberg)
- Reasonable liquidity
- Excellent credit
- Underlying bond futures have convexity due to delivery options

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# OTC Options

△ The key feature of the OTC market is the ability to obtain a two-way market in virtually any interest-rate swap or option product

- **Unlike Exchange Traded, an investor can specify:**
  - Underlying
  - Maturity
  - Expiry and expiry type
  - Payoff
  - Size
- **Most liquid market:**
  - European options on bullet swap rates (European swaptions)

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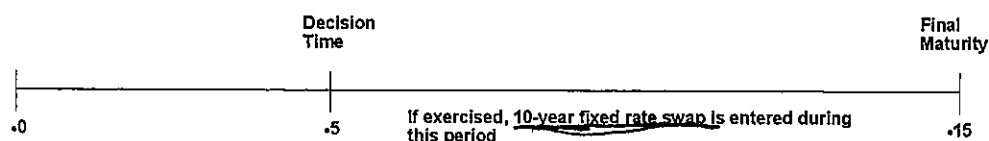
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## OTC Options: Swaptions

- Option to enter into an interest rate swap
- Most liquid and actively traded OTC options
- Wide range of option expiries: 1 month to 20 years
- Wide range of underlying swap maturities: (1 year to 30 years)

*Example:*

A 5-year expiry option, European style, with the right to pay 5% fixed S/A 30/360 vs. 3-month LIBOR for 10 Years ("A 5-into-10 5% Payor")



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## OTC Options: Swaptions

### • Payor Swaption ~~call~~

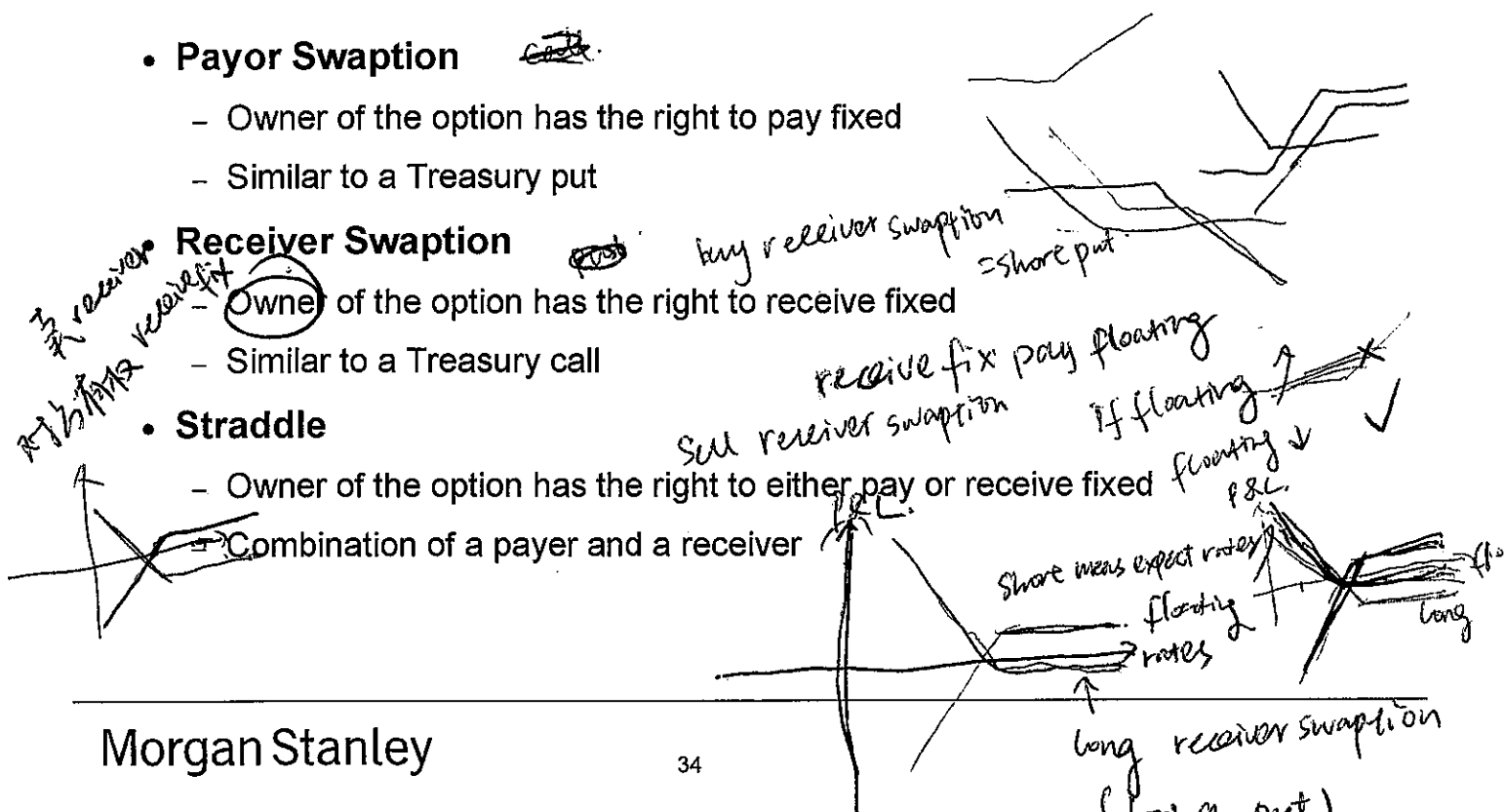
- Owner of the option has the right to pay fixed
- Similar to a Treasury put

### • Receiver Swaption ~~put~~

- Owner of the option has the right to receive fixed
- Similar to a Treasury call

### • Straddle

- Owner of the option has the right to either pay or receive fixed
- Combination of a payer and a receiver



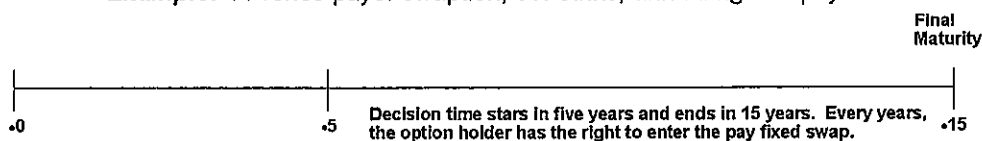
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## OTC Options: Swaptions

### • Bermudan Swaption: Right to exercise the option periodically

**Example:** A 15nc5 payer swaption, 6% strike, annual right to pay



- Bermudan options trade often, though vega and gamma risk is complex to model
- Bermudan options better replicate the prepayment option in a mortgage than European options

### • American Swaption: Right to exercise the option over the exercise period on any day

- American options are least frequently traded

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## OTC Options: Caps and Floors

- Options on 3-Month LIBOR
- Option resets monthly, quarterly, or semiannually
- Maturities typically range from 6 months to 20 years
- Good liquidity
- Represent a “string of options”. A European swaption, in contrast, is only one option

### Example:

- A 10-year expiry cap on 3M LIBOR struck at 6% (Quarterly, Act/360). Cap resets quarterly.
- The option is composed of 40 individual “caplets” or options on 3M LIBOR.
- If one caplet is in the money, the option holder receives a payout over that period.

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## OTC Options: CMS Options and Exotics

### • Constant-Maturity-Swap Options

- Caps or floors on 2, 5, 10, 30 year CMS
- The payoff structure is the same as for LIBOR caps/floors; however, the underlying index is CMS
- Similar to a “string” of European swaptions
- CMS set according to ISDAFIX

### • Structured (Exotic) Products

- Typically understood to encompass all products not previously mentioned
- Options on a wide variety of underlying variables

#### – Example:

- One year call option on the yield curve spread between 10-year CMT and 2-year CMT struck at zero basis points
- In one year, observe the spread between the 10-year CMT and the 2-year CMT; if the spread is positive, the customer receives that amount
- This allows the customer to put on steeper view with limited (premium) downside

~~Long forward short the market~~ receives floating. pay fixed.

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# Market Participants

## • Dealers

- 5-10 large market makers
- 20-25 smaller dealers

## • End users

- Government agencies (FNMA, FHLMC, FHLB)
- Mortgage servicers
- Asset managers / Central banks
- Banks
- Corporates
- Insurance Companies
- Supranationals
- Hedge Funds

## • Mortgage Hedging

- Due to the size and scope of the US mortgage market and the negative convexity of US mortgages, the options market is needed and very actively traded as a hedging and trading vehicle

*P-measure*

$$dB_t = R_{\text{grow}} S_t dt + \sigma S_t dW_t$$

*let  $X = \log S$*

$$dX_t = \nu dt + \sigma dW_t$$

$$\nu = R_{\text{grow}} - \sigma^2/2$$

$$\text{Var}(X_t) = \sigma^2 t$$

$$\text{SD}(X_t) = \sigma \sqrt{t}$$

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# Lognormal Volatility

## • Implied Lognormal Volatility ("Black-Scholes Volatility")

- Defined such that  $\sigma^*(S_{\text{art}}(T))$  is the standard deviation of the terminal distribution of the log of the rate at time  $T$
- The most popular measure of implied and actual interest rate volatility
- Because a lognormal model assumes that the standard deviation of the log rate is constant, the standard deviation of the rate is a function of the level of interest rates

$$\ln T = \log r$$

## • Example:

- Constant lognormal volatility means that as rates go from 6% to 4%, the implied basis point volatility would decrease by one-third
- 6% x 20% = 120 bp
- 4% x 20% = 80 bp

$$dS_t = \mu S_t dt + \sigma S_t dW_t$$

$$dX_t = \nu dt + \sigma dW_t$$

$$dX = \mu dt + \sigma dZ_t$$

$$\text{Var}(\Delta X) = \sigma^2 T$$

The market prices options using a risk-neutral distribution of log-returns


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with fatter tails than normal.

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$$\frac{1}{4} \log S_t \quad \frac{1}{4} \cdot \frac{1}{4} \quad \frac{1}{4} \cdot -\frac{1}{4}$$

# Normalized Volatility

- Normalized Volatility ("Rate Adjusted Volatility") <sup>martingale measure</sup> ~~break even~~ ~~Gamma~~ ~~Theta~~
    - Normalized vol ( $\tau$ ) is defined such that  $\tau \cdot (\text{Sqrt}(T))$  is the standard deviation of the terminal distribution of the *rate* at time T  <sup>$\tau \cdot T$</sup>  
    - Approximately equal to Black-Scholes vol multiplied by the forward rate <sup>lognormal vol = rate</sup>
    - Used to compare the uncertainty of rates regardless of the level of rates
    - Important to use when comparing volatility levels across different rate environments
  - Implied basis point volatility <sup>measure in bp</sup> remains constant through all interest rate levels
    - For example, if the implied normalized volatility of a particular rate is 100 bp a sell-off from 4% to 5% must be met by a proportionate decrease in implied lognormal volatility from 25% to 20%
      - $4\% \times 25\% = 100 \text{ bp} = 5\% \times 20\%$   <sup>$\frac{F}{\sigma_{LN}}$   $\frac{ON}{\sigma_N}$</sup>
    - The relationship of lognormal volatility between the two rate environments under a normalized model can be defined as the inverse of the two rates
- $dS_t = \sigma dW_t$  <sup>Martingale</sup> <sup>new  $\frac{20}{25} = \frac{4}{5}$</sup>  <sup>old</sup>

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$$\theta = -0.5 \cdot \sigma^2 \gamma$$

$$PRL = \theta \cdot t + 0.5 \gamma \cdot \Delta F^2$$

$$= 0.5 \gamma (\Delta F^2 - \sigma^2 F^2)$$

$$\rightarrow 0 \text{ If } > 0 \text{ only if}$$

$$\Delta F > \sigma \sqrt{T} F = \text{normal vol.}$$

$$dX_t = \mu dt + \sigma dW_t$$

$$SD(X_t) = \sigma \sqrt{T}$$

## Drivers of Volatility

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## Short Expiry Volatility

- Dealers delta hedge their option exposures
- Profit from long option position depends on realized volatility
- Implied vol = market's best estimate of realized volatility during the life of the option
  - If implied volatility is equal to actual volatility, hedging profit equals premium
- Historical realized volatility is one of the most important inputs to the market's estimate
- Implied volatility in the US tends to trade higher than actual volatility

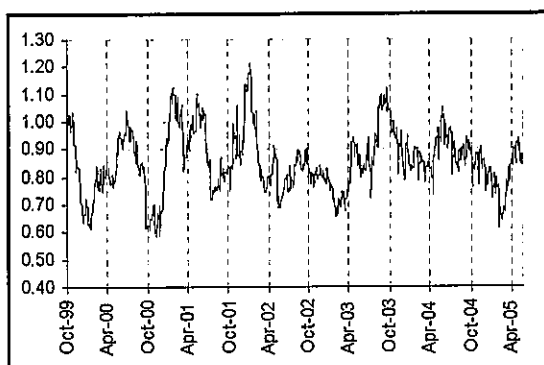
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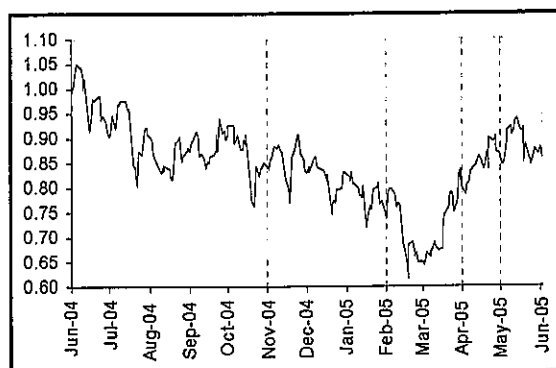
## Actual vs. Implied Normalized Volatility

For options with expiries of 6m and less, one of the biggest drivers of implied volatility is *recent actual volatility*

3m5y Actual / Implied  
(Last 5 years)



3m5y Actual / Implied  
(Last Year)



Currently, 3-month rolling actual normalized volatility has richened relative to the level of 3m5y implied volatility

Source: Morgan Stanley

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# Long Expiry Volatility

- **For Options of 1-year expiry and greater:**
  - Supply and demand is much more important than realized volatility
- **High vega risk, low gamma risk**
  - Vega: Risk to movements in implied volatility
  - Gamma: Risk to movements in actual market volatility
- **Dealer risk limits are important factors**

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## Supply and Demand: Long Expiry Options

### Supply

- **Agency callable issuance being hedged**
  - FHLBs hedge callable issuance
- **Corporate call monetization (sell the calls they effectively buy when issuing a callable bond)**
- **Puttable and cancelable swaps**
  - FHLBs provide puttable loans that are then hedged with dealers
- **Structured notes**
  - Investors are typically selling volatility to enhance yield

### Demand

- **Mortgage portfolios (largely FHLMC and FNMA)**
  - Combined portfolio of approximately \$1.5 trillion in MBS
  - Issue callable debt and purchase OTC options to hedge the mortgage portfolio's negative convexity
- **Mortgage servicers (CMS floors)**
- **Bank balance sheet management (LIBOR caps, swaptions)**

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# Morgan Stanley Quotient

## Interactive Rates Grid

- The MSQ Interactive Rates Grid allows the user to understand the swap rate surface
- Expiries range from 0M to 30Y while maturities range from 1Y to 30Y
- The user can select the type of metric to evaluate the level of rates (Percentile, Z-score), how to measure carry and over what period to measure it
- The period over which to measure changes can also be customized
- The user can also select specific rates and use the 'Add to Plotting Tool' Feature to plot the historical rates

Swap Rates Grid May 22, 2008

Trade	Carry Type	Level Metric	Historical Period	Realized Period
Rate	Roll-down and Carry	Percentile	5y	3m

Market	Carry Horizon	Carry Metric	Changes
Select Market	3m	Carry Quotient	1d

	1Y	2Y	3Y	4Y	5Y	7Y	
0M	2.93	14.79	3.32	15.9	3.63	4.74	3.86
	38.30%	0.24	57.97%	0.2	37.25%	0.1E	25.99%
	10.02		14.72		15.73		15.99
							16.10
							14.55
1M	2.99	20.69	3.33	19.3	3.68	4.40	3.90
	33.54%	0.28	57.89%	0.22	36.74%	0.19	24.95%
	12.91		16.21		16.62		16.42
							16.52
							14.78

Key	Rate	128.8	1.13	Carry
Rate Metric	12.1%	70.1%	Carry Metric	
Daily Change	(0.7)			

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# Morgan Stanley Quotient

## Security Lookup Tool

- Access the Security Lookup Tool by click the Lookup icon (magnifying glass) on the Entry Palette in the MSQ Plotting Tool

SECURITY SEARCH

Select currency/region: Currency: GBP

Asset Class: FX

Select asset class

Tenor

	Spot	0M	1M	1W	1M	2M	3M	6M
EURGBP	1			1W	1M	2M	3M	6M
CRPAUS	1			1W	1M	2M	3M	6M
GBPTRL	1			1W	1M	2M	3M	6M
GBPCLD	1			1W	1M	2M	3M	6M
GBPCHF	1			1W	1M	2M	3M	6M
CRDPKX	1			1W	1M	2M	3M	6M
GBPHKO	1			1W	1M	2M	3M	6M
GBPSGO	1			1W	1M	2M	3M	6M
GBPUSD	1			1W	1M	2M	3M	6M

Slide to see all securities

Click to select

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# Morgan Stanley Quotient Interactive Analytics

- The MSQ Interactive Analytics allow the user to sort through a wide range of customizable metrics on swap rates and swaption volatility

**Select Interactive Analytics or PDF Analytics** | **Select Analytic Category** | **Select Trade Type and Market** | **Define securities** | **Filter grid calculations** | **Plotting Tool**

**Morgan Stanley** | **PLOTTING TOOL**

**Swaption Volatility Screen**

Start	End	Vol	Change	Average	Percentile	Implied Vol	Average	Percentile
161.64	14.55	14.29	10.20%	0.84	1.00	0.10%		
148.43	0.31	19.82	10.42%	0.73	0.17	1.41%		
119.65	11.18	19.48	10.15%	0.74	0.39	15.18%		
118.19	2.42	18.99	10.41%	0.79	0.88	8.27%		
117.52	1.42	18.29	10.43%	0.83	0.72	4.42%		
103.19	0.91	18.11	10.40%	0.89	1.04	1.00%		
127.85	3.53	14.67	10.10%	0.52	1.37	3.81%		
109.48	0.48	14.68	10.45%	0.77	1.04	3.91%		
149.44	1.87	103.10	10.10%	0.77	1.34	0.71%		
109.17	10.44	19.20	10.10%	0.98	1.33	23.10%		
80.07	0.23	14.57	10.10%	0.69	0.16	0.70%		

Ctrl + Click to select more than one analytics to plot

Level and Level Metric data

Carry and Carry Metric data

**Add to Plotting Tool**  
 Stop  
 Reset  
 Submit

Add to Plotting Tool. Adds securities to Plotting Tool security grid  
 Stop. Stops the query  
 Reset. Resets filters to the default values  
 Submit. Displays the selected filtered values

Change sort order by any column header

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You should now be able to:

- Use swap duration and convexity to measure your risk and determine your exposure
- Explain the uses of Interest Rate Options, who uses them and why
- Converse with your clients about various trading strategies they can execute using Interest Rate Derivatives, including duration, curve, swap spread, forward, and butterfly strategies

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3.625% ↑ 100 / (3770) %

$$\frac{C/2}{(1+i_1)} + \frac{C/2}{(1+i_1)^2} + \frac{P}{(1+i_1)^2} = \frac{C}{(1+i_2)} + \frac{P}{(1+i_2)}$$

$$\frac{C}{2} \cdot (1+i_2)(1+i_1) + \frac{C}{2} (1+i_2) + P(1+i_2) = C(1+i_1)^2 + P(1+i_1)^2$$

$$C(1+i_2)(1+i_1) + C(1+i_2) + 2P(1+i_2) = 2C(1+i_1)^2 + 2P(1+i_1)^2$$

$$C(1+i_2)(1+i_1) + (C+2P)(1+i_2) = (2C+2P)(1+i_1)^2 \quad (1+i_2)(1+i_1)^2(C+P)$$
~~$$C(1+i_2) \cdot C(1+i_2)(C+P)$$~~
~~$$(1+i_2)(C+Ci_1+C+2P) = (2C+2P)(1+i_1)^2$$~~

$$C(1+i_1+1+i_1i_2) + C+Ci_2+2P+2Pi_2 = 2C+2P+4Ci_1+4Pi_1+2i_1^2C+2i_1^2P$$

$$C+Ci_1+Ci_2+Ci_1i_2 + C+Ci_2+2P+2Pi_2 = 2C+2P+4Ci_1+4Pi_1+2i_1^2C+2i_1^2P$$
~~$$2+2P+2C+2Ci_1+2Pi_1$$~~

$$2Pi_1^2 + 2Ci_1^2 + 3Ci_1 + 4Pi_1 - 2Pi_2 - Ci_2 - C Ci_1i_2 = 0$$

$$(C+2C)i_1^2$$