# Basics of FX Options and FX Option Trading Strategies

FX Derivatives Research

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**See the end pages of this presentation for analyst certification and important disclosures.**

# Agenda



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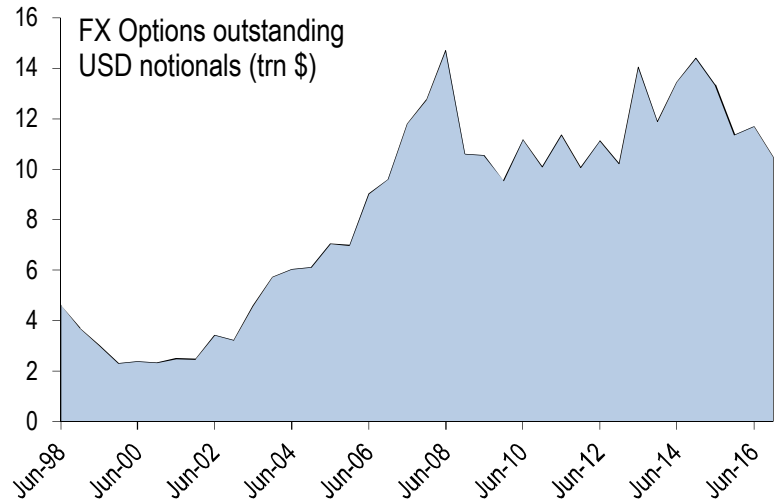
# THE FX OPTIONS MARKET – VOLUMES (source: BIS data, May 2016)

FX Options volume:

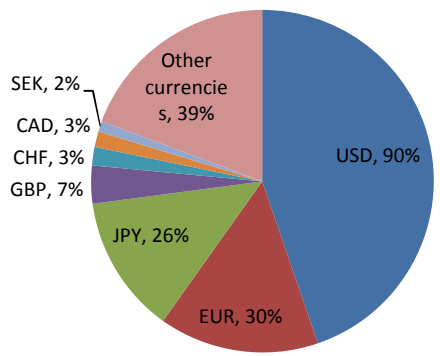
Covers G10 countries + Switzerland

Excluded: Asia, Latam, CEEMEA

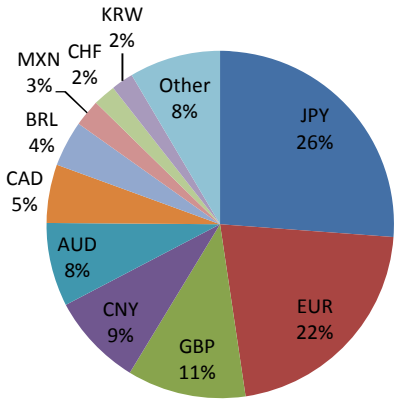



Source: BIS, J.P. Morgan

Outstanding notionals by currency

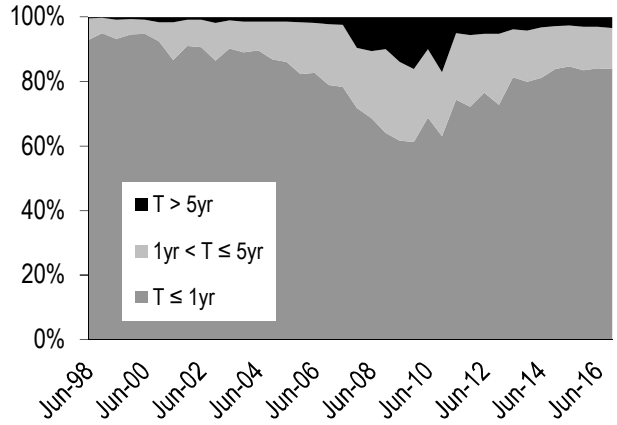



Turnover vs. USD




Source: J.P. Morgan

Maturities:




Source: BIS, J.P. Morgan

Market participants:

- Market makers
- Institutionals / Hedge funds
- Real Money Managers
- Dealers of structured products
- Corporates
- HNW
- Etc...

Strategies:

- Speculation, alpha P&L generation
- Leveraging macro views
- Hedging
- Monetizing directional views/ranges
- Etc...

BASICS OF OPTIONS



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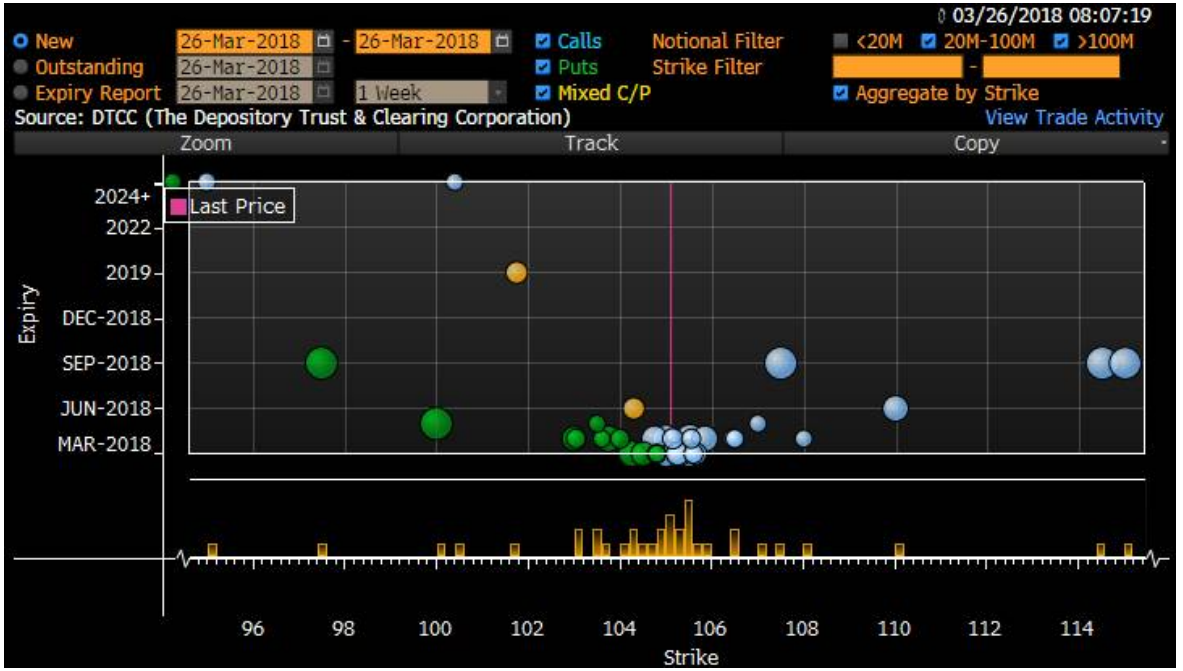
## OMST (USDJPY Currency) - MARKET POSITIONING (DTCC)

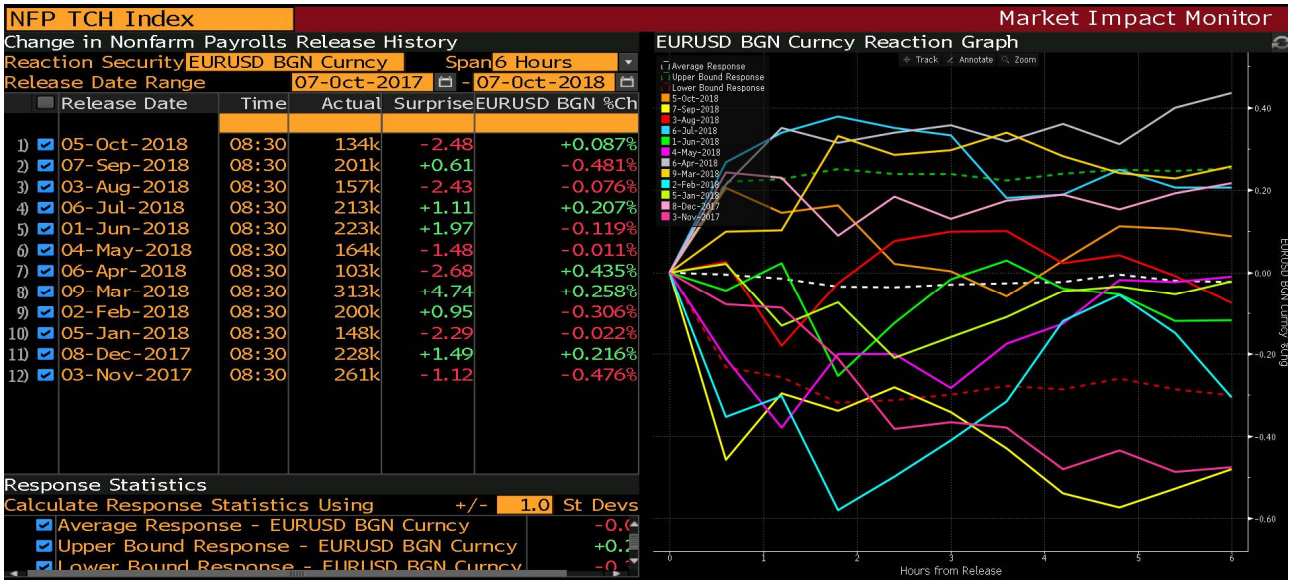



Source: Bloomberg

## SDRV - DERIVATIVES VOLUMES: (DTCC)


Source: Bloomberg

## ECMI

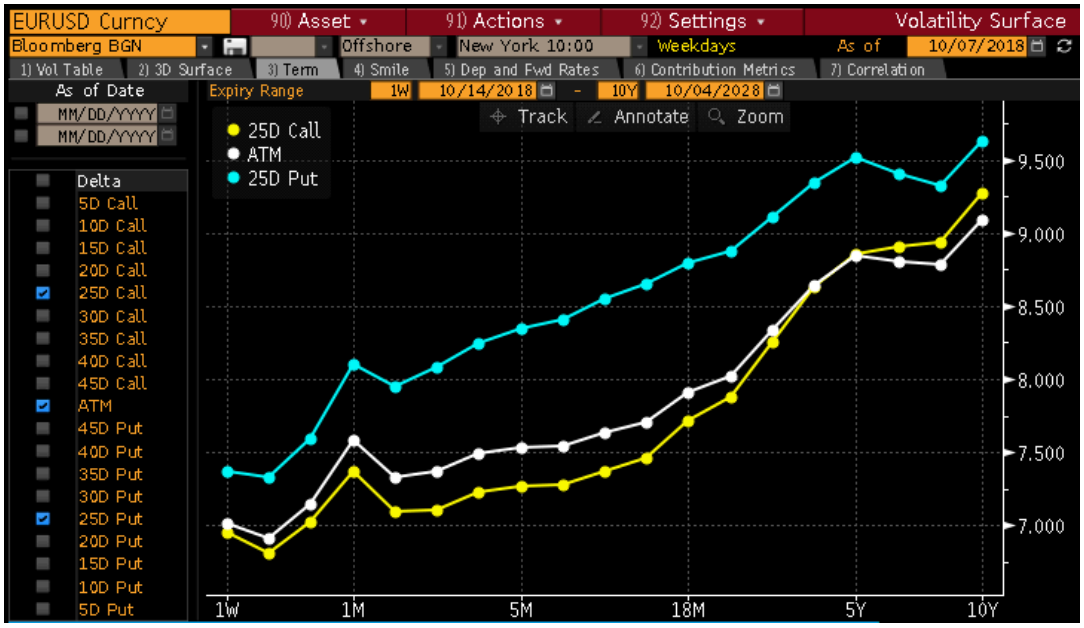



Source: Bloomberg

## VOLC

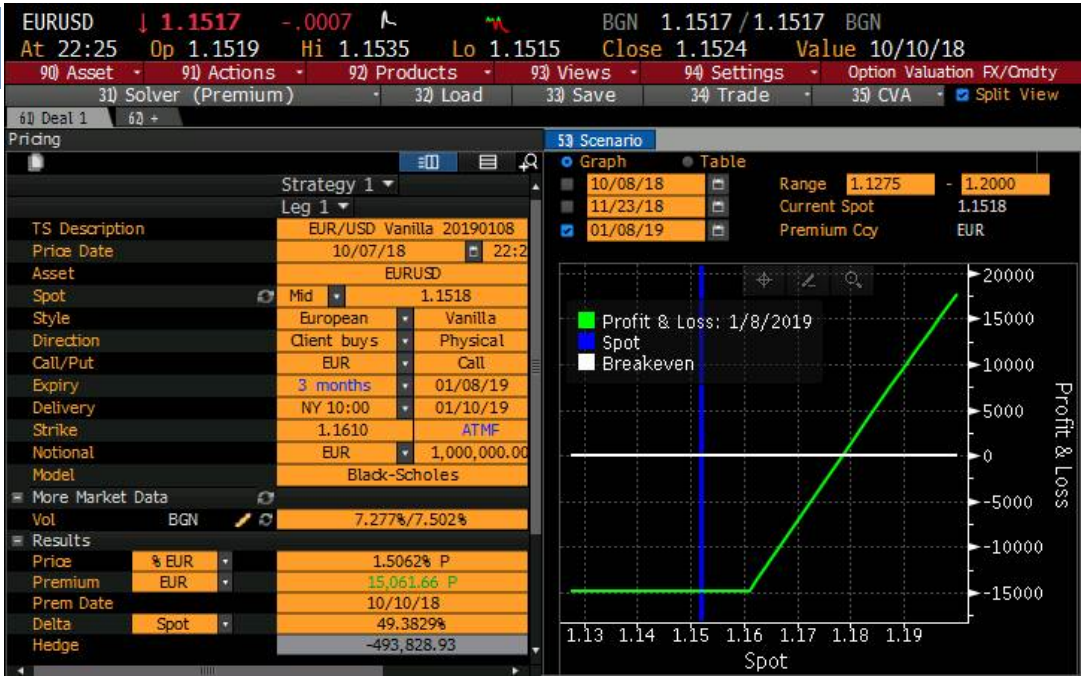

Source: Bloomberg

## OVDV




Source: Bloomberg

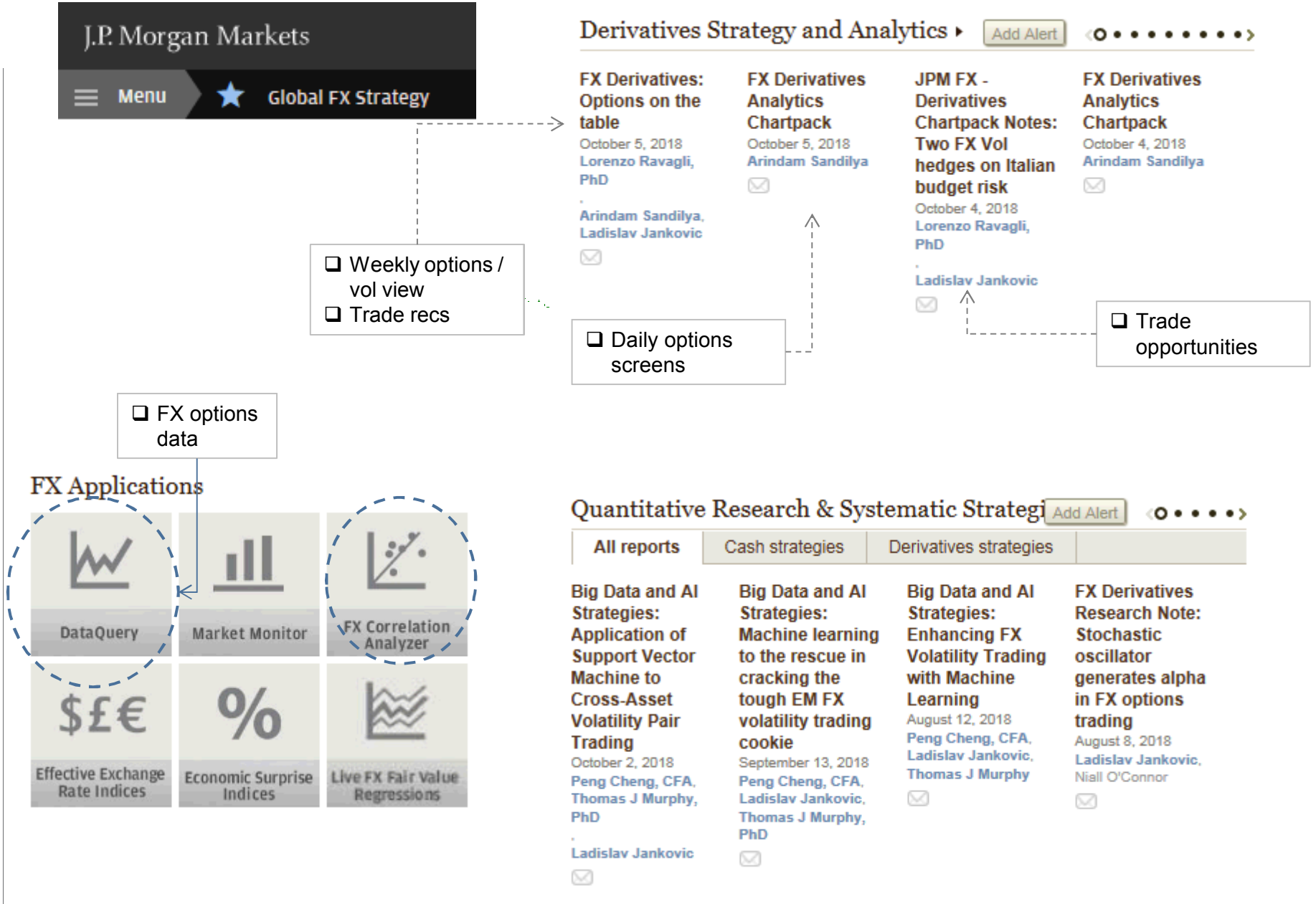
## OVML




Source: Bloomberg

**Options news BBG screens:**

- ❑ **FXvolcol**
- ❑ **FXdrv**




Source: J.P. Morgan

# OPTION TERMINOLOGY

| | |
|---|---|
| **Option** | The right, but not the obligation, for the holder to buy or sell a certain currency against another, at a certain rate, at/by a certain date in the future. |
| **Call** | The right to buy/receive the underlying currency (simultaneously a counter currency put). |
| **Put** | The right to sell/deliver the underlying currency (simultaneously a counter currency call). |
| **Strike/Exercise Price** | The pre-agreed rate at which currencies are exchanged if the option is exercised. |
| **Exercise** | The process by which the right is taken up. |
| **Exercise/ Expiry Date** | The last date on which the holder of the option may choose to effect the currency transfer at the strike rate. The latest time is usually 10:00 am NY time. |
| **Settlement/Value/ Delivery Date** | Options usually settle for spot value. This is most often the second business day after the exercise date, when funds will transfer. |
| **Premium** | Option value – usually payable by the option buyer/holder two business days after the transaction date. |
| **European Style** | An option which may be exercised only on expiry date with funds to be transferred on the maturity date. |
| **American Style** | An option which may be exercised at any time until expiry date with funds to be transferred for spot value from exercise date. |
| **At-the-money forward (spot)** | An option whose strike is equal to the current forward outright (spot) price. |
| **In-the-money forward (spot)** | An option whose strike is more favorable to the holder than the current forward outright (spot) price. |
| **Out-of-the-money forward (spot)** | An option whose strike is less favorable to the holder than the current forward outright (spot) price. |

| | |
|---|---|
| **Name** | **Vanilla Option1** |
| **Type** | Vanilla Option |
| **Market Date** | Mon 14Sep2015 |
| **Market State** | Mkt2 |
| **FX Pair** | USD/JPY |
| **Option Type** | Call on USD |
| **Expiration Date** | **Tue 13Sep2016 [365d]** |
| **Settlement Date** | Thu 15Sep2016 |
| **Strike** | **119.47** |
| **Settlement Type** | Physical |
| **Settlement Currency** | N/A |
| **Expiration Cut** | NYC |
| **Quantity Currency** | USD |
| **Quantity** | 100,000,000 |
| **Buy/Sell** | b - JPM Buys |
| **Spot** | **120.19/120.21** |
| **Forward** | 119.04/119.08 |
| **Forward Point** | -1.146/-1.128 |
| **Denominated Depo** | -0.40 |
| **Asset Depo** | 0.54 |
| **Vol for strike** | **10.259/10.508** |
| **ATM Volatility** | 10.392 |
| **Premium Display** | % USD |
| **Price(%)** | **3.8990/4.0134** |
| **Price(Pips)** | **0.00032636/0.00033593** |
| **Edge Style** | Marked |
| **Edge (%)** | 0.057 |
| **BS+TS TV (%)** | **3.960** |
| **BS+TS TV (Pips)** | **0.00033142** |
| **+ PriceExtra** | |
| **BS Delta (%)** | 46.52 |
| **BS Spot Delta (%)** | 46.52 |
| **BS Forward Delta (%)** | 46.77 |
| **Adapted Forward Delta (%)** | 46.65 |
| **Adapted Delta (%)** | **46.40** |
| **Adapted Gamma (%)** | 4.91 |
| **Vega (%)** | Sh-F9 to calc |
| **BS Vega (%)** | 0.40 |

USER INPUTS

Source: J.P. Morgan

# CALL OPTION PAYOFF AT EXPIRATION

Call option payoff = Max (S-K, 0)

where S = price of underlying, K = exercise price

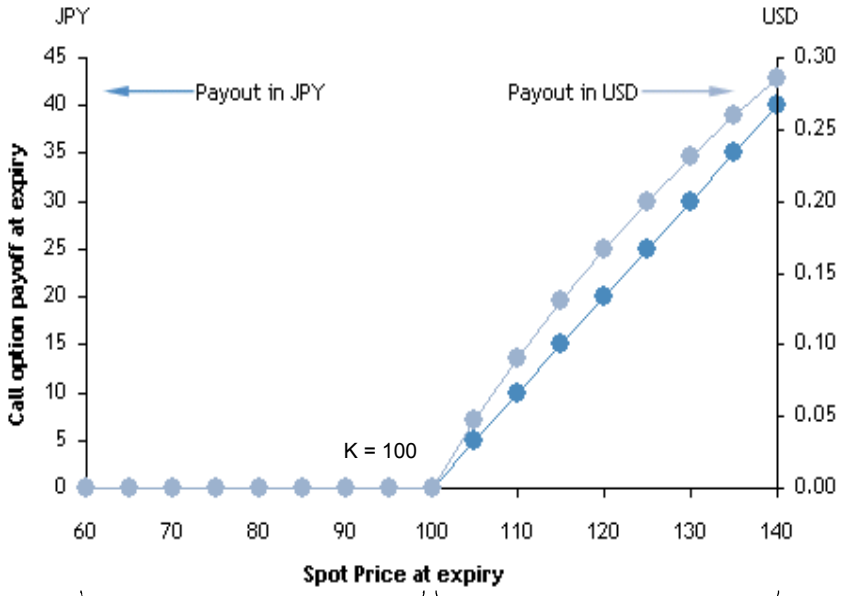
| S | Max (S-K, 0) | Max (S-K,0)/S |
|---|---|---|
| 60 | 0 | 0 |
| 65 | 0 | 0 |
| 70 | 0 | 0 |
| 75 | 0 | 0 |
| 80 | 0 | 0 |
| 85 | 0 | 0 |
| 90 | 0 | 0 |
| 95 | 0 | 0 |
| 100 | 0 | 0 |
| 105 | 5 | 0.0476 |
| 110 | 10 | 0.0909 |
| 115 | 15 | 0.1304 |
| 120 | 20 | 0.1667 |
| 125 | 25 | 0.2000 |
| 130 | 30 | 0.2308 |
| 135 | 35 | 0.2857 |

Source: J.P. Morgan

Yields payout in numeraire currency pips per unit of asset currency notional e.g. JPY per USD in the case of USD/JPY. To convert JPY payout into USD, divide by the going spot rate at expiry i.e. **USD payout = max (S-K,0)/S**

The linear profile shown below therefore only holds when payout is plotted in numeraire currency pips. The payout profile is **NOT** linear when plotted in terms of the asset currency

An option that delivers a linear payout profile in the asset currency is called a **QUADRATIC** option.




Source: J.P. Morgan

# PUT OPTION PAYOFF AT EXPIRATION

Put option payoff = Max (K-S, 0)

where S = price of underlying, K = exercise price

| S | Max (K-S, 0) | Max (K-S,0)/S |
|---|---|---|
| 60 | 40 | 0.6667 |
| 65 | 35 | 0.5385 |
| 70 | 30 | 0.4286 |
| 75 | 25 | 0.3333 |
| 80 | 20 | 0.2500 |
| 85 | 15 | 0.1765 |
| 90 | 10 | 0.1111 |
| 95 | 5 | 0.0526 |
| 100 | 0 | 0 |
| 105 | 0 | 0 |
| 110 | 0 | 0 |
| 115 | 0 | 0 |
| 120 | 0 | 0 |
| 125 | 0 | 0 |
| 130 | 0 | 0 |
| 135 | 0 | 0 |

Source: J.P. Morgan

Yields payout in numeraire currency pips per unit of asset currency notional e.g. JPY per USD in the case of USD/JPY. To convert JPY payout into USD, divide by the going spot rate at expiry i.e. **USD payout = max (K-S,0)/S**

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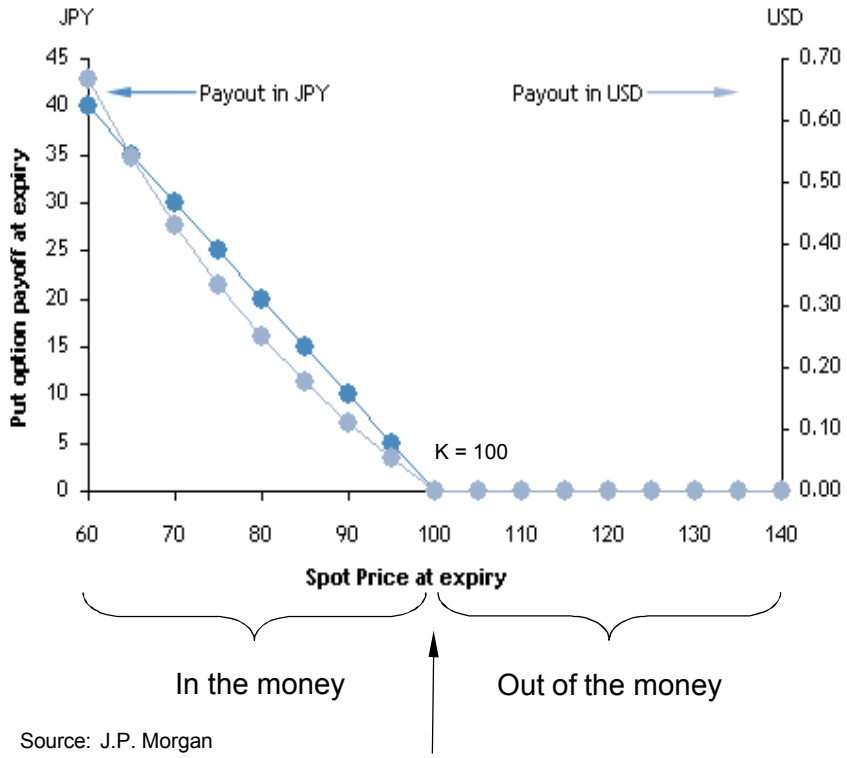
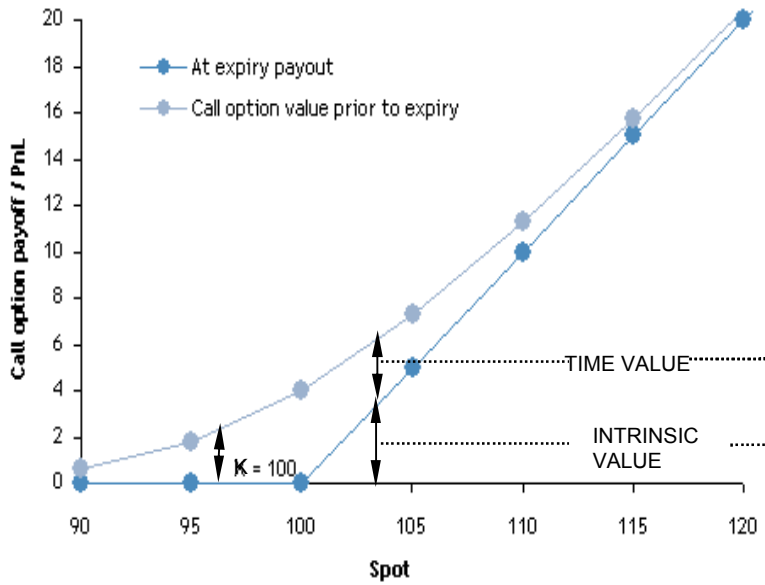


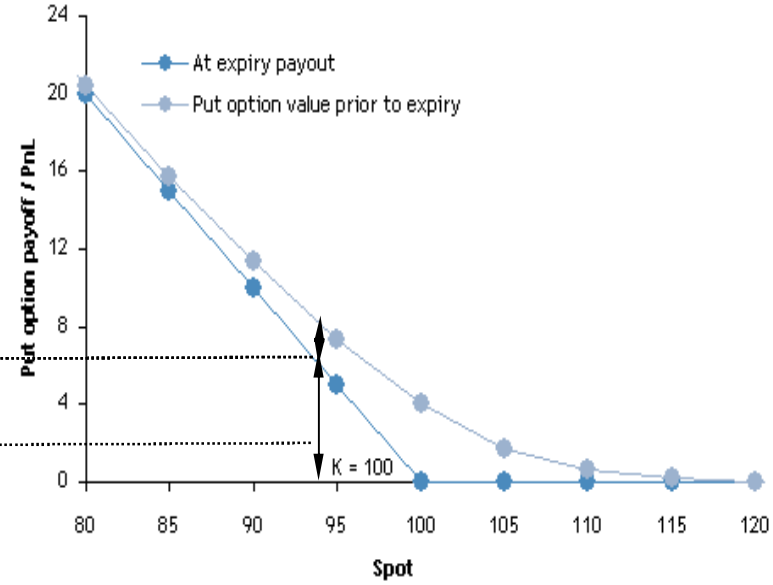

Source: J.P. Morgan

## INTRINSIC VALUE AND TIME VALUE

- Prior to expiration, call options trade at prices higher than their "in-the-moneyness", also referred to as their intrinsic value.
  - Intrinsic value of an in-the-money call = S – K
  - Intrinsic value of an in-the-money put = K – S
  - Intrinsic value of out of the money options = 0
- The difference between the option value and the intrinsic value is the time value of the option. Time value represents the additional value of an option due to the opportunity for the intrinsic value of the option to increase.
- **Option Value = Intrinsic value + Time value**




Source: J.P. Morgan




Source: J.P. Morgan

# OPTION PREMIUM QUOTATION

## Conventions

Assume that USD/JPY is the currency pair of interest.

- USD is referred to as the base or **asset** currency, JPY is referred to as the terms or **numeraire** currency
- Option premium can be expressed in
  - **Percent of asset currency notional (% USD)**
  - Percent of numeraire currency notional (% JPY)
  - Units of numeraire currency per unit notional of the asset currency (JPY per USD)
  - Units of asset currency per unit notional of the numeraire currency (USD per JPY)

## Example

The two-way premium of a **6M 90** strike USD put / JPY call (spot **90.25**) in $10MM may be expressed as:

1. 4.07 – 4.17% $
2. 4.08 – 4.19% ¥
3. ¥ 3.6775 – 3.7710 per $
4. $ 0.045250 – 0.046333 per ¥

- Buy Option in $ 10MM : Premium = $ 417,000
- Buy Option in ¥ 900MM : Premium = ¥ 37,710,000
- Buy Option in $ 10MM : Premium = ¥ 37,710,000
- Buy Option in ¥ 900MM : Premium = $ 417,000

## Conversion from one convention to another

AC = Asset Currency

NC = Numeraire Currency

- $\%AC = \%NC \times \frac{Strike}{Spot}$
- $\%NC = \%AC \times \frac{Spot}{Strike}$
- $NC\ per\ AC = \%NC \times Strike$
- $AC\ per\ NC = \frac{\%AC}{Strike}$

In the earlier example, the USD/JPY option is offered at 4.19% JPY, spot is 90.00 and the strike of the option is 90.25; hence the price of the option in JPY per unit USD notional is

JPY per USD = 4.19% x 90 = 3.7710

or 377 JPY pips per USD

$$\text{NC pips} \xrightarrow{\times \frac{1}{S_0}} \%\ \text{AC} \xrightarrow{\times \frac{S_0}{K}} \%\ \text{NC} \xrightarrow{\times \frac{1}{S_0}} \text{AC pips} \xrightarrow{\times S_0 K} \text{NC pips}$$

# PAYOUT vs. P/L PROFILES

- P/L of an option differs from its payout by the amount of the option premium.
- Because option premium is non-zero, there is a breakeven spot rate only beyond which an option trade makes or loses money at expiry.
- Breakeven spot rates:
  - **Call options**: Strike + Premium
  - **Put options** : Strike - Premium

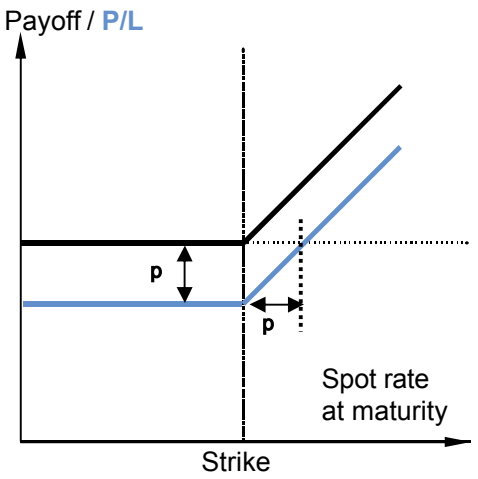
- **Example**

Q. What is the breakeven spot rate for a 1.50 strike EUR call/USD put that costs 1.0% EUR? Spot =1.45

Ans.

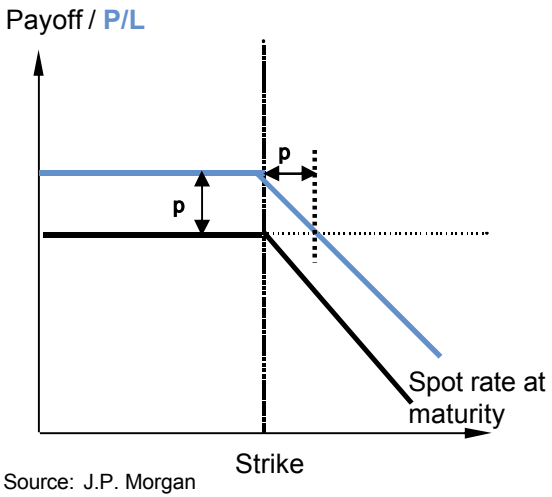
- Convert 1.0% EUR to USD per EUR
  1) % USD = % EUR * Spot / Strike
     = 1 * 1.45/1.50 =0.97%
  2) USD per EUR = % USD * Strike
     = 0.97%*1.50 = 0.0145
- Breakeven spot rate
  = Strike + Premium
  = 1.50 + 0.0145 = **1.5145**

## Long Call



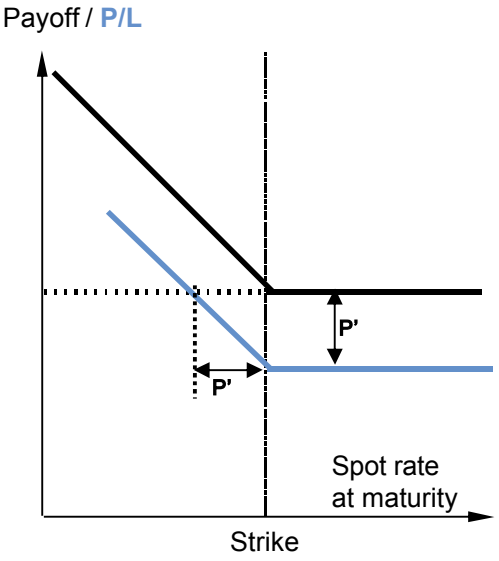

Source: J.P. Morgan

## Short Call



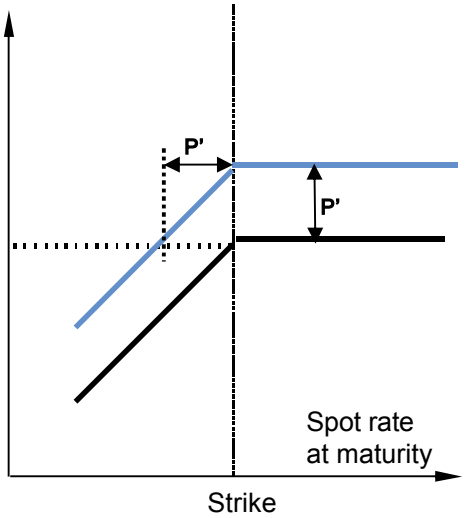

Source: J.P. Morgan

## Long Put




Source: J.P. Morgan

## Short Put




Source: J.P. Morgan

# PUT CALL PARITY

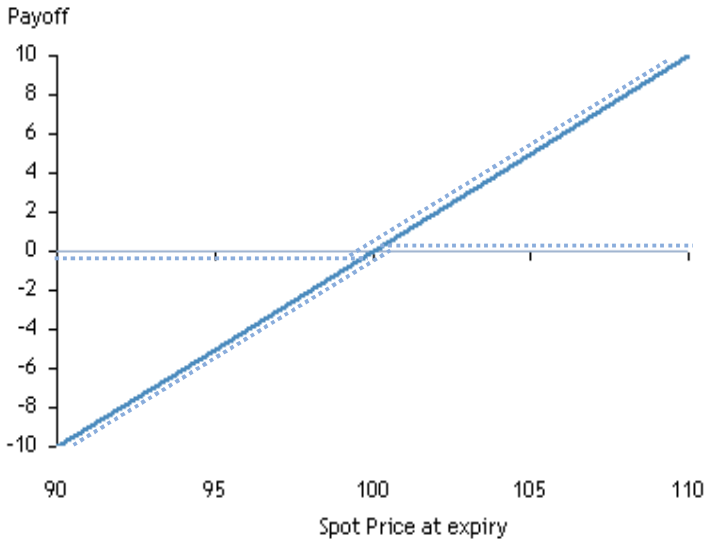
## Buy a call + sell a put = Synthetic long forward

Assume 6M USD/JPY forward is at 100
Consider the following position

- Long a 6M 100 strike USD Call / JPY Put
- Short a 6M 100 strike USD Put / JPY Call

**Payout Table**

| | | 90 | 95 | 100 | 105 | 110 |
|---|---|---|---|---|---|---|
| A | Long USD Call / JPY Put MAX (S-K,0) | 0 | 0 | 0 | 5 | 10 |
| B | Short USD Put / JPY Call - MAX(K-S,0) | -10 | -5 | 0 | 0 | 0 |
| A+B | Long USD Call + Short USD Put | -10 | -5 | 0 | 5 | 10 |
| C | Long Forward (S - K) | -10 | -5 | 0 | 5 | 10 |




Source: J.P. Morgan

## Put-Call Parity Relationship for any strike K

$$C - P = S e^{-r_f T} - K e^{-r_d T}$$

or, given that $F = S e^{(r_d - r_f)T}$

$$C - P = e^{-r_d T}(F - K)$$

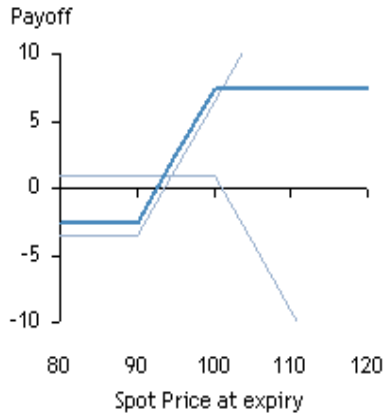
## Implications

- One can replicate any of (put, call, forward) using the other two instruments
- ATMF calls and puts have the same price (plug F = K in the second put call parity expression)

# BASIC OPTION STRATEGIES

## Call Spread

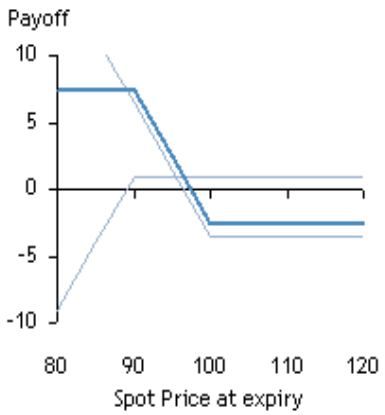
**Long 90 Call + Short 100 Call**




Source: J.P. Morgan

## Put Spread

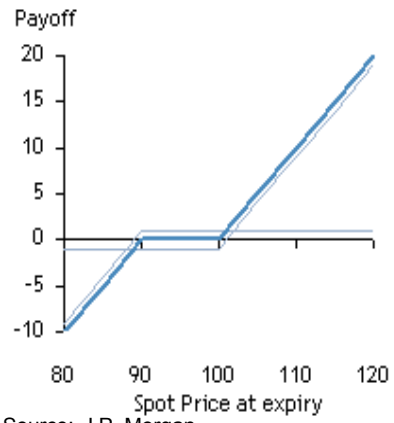
**Long 100 Put + Short 90 Put**




Source: J.P. Morgan

## Risk-Reversal

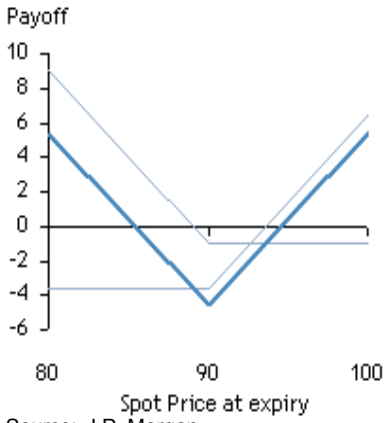
**Long 100 Call + Short 90 Put**




Source: J.P. Morgan

## Straddle

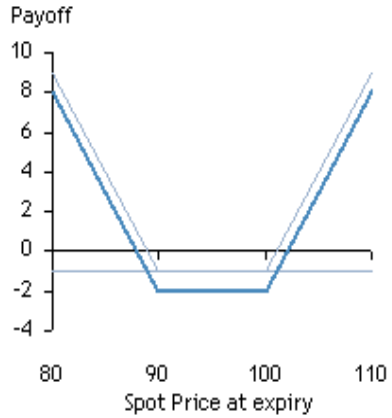
**Long 90 Call + Long 90 Put**




Source: J.P. Morgan

## Strangle

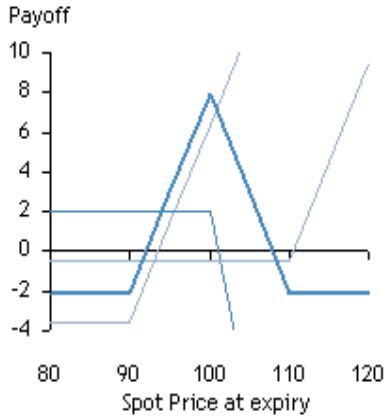
**Long 90 Put + Long 100 Call**




Source: J.P. Morgan

## Butterfly

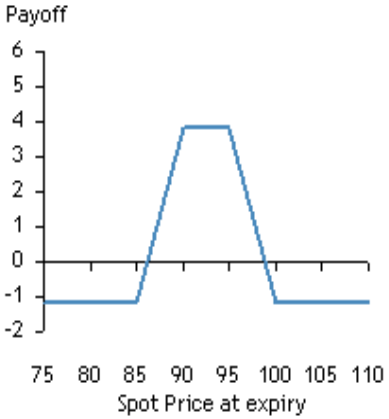
**Long 90 Call + 2* Short 100 Call + Long 110 Call**




Source: J.P. Morgan

## Condor

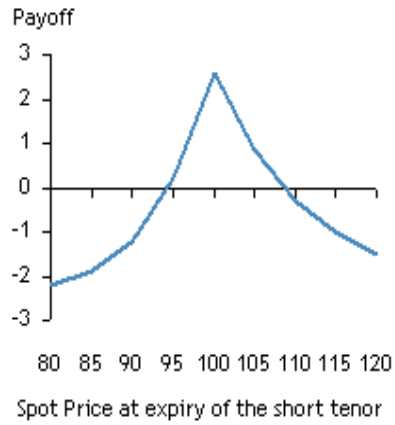
**Long 85 Call + Short 90 Call + Short 95 Call + Long 100 Call**



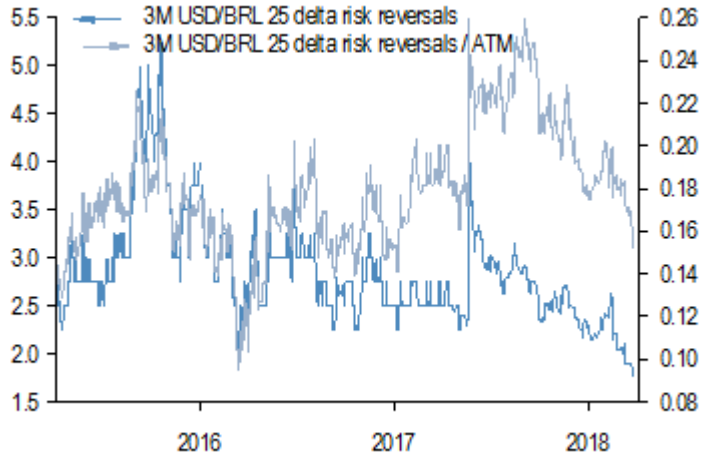

Source: J.P. Morgan

## Calendar Spread

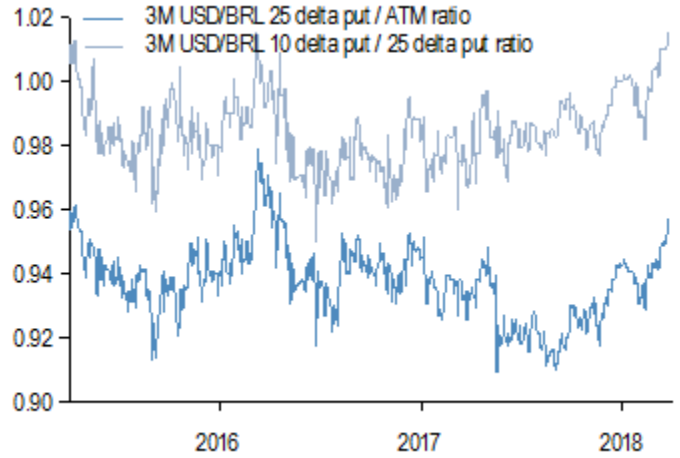
**Short 3M 100 Call + Long 1Y 100 Call**




Source: J.P. Morgan




Source: J.P. Morgan




Source: J.P. Morgan

| Pair | Spot | Ten | OT | Structure |
|---|---|---|---|---|
| USD/BRL | 3.3129 | 3M | Put | 1X1 |

| K Near | K Far | P Near (bp) | P Far (bp) | Spread Price (bp) | Max Payout (bp) | Max Payout Cost Ratio | Discount To Outright Vanilla | Net Delta | Net Vega (bp) |
|---|---|---|---|---|---|---|---|---|---|
| 3.2941 | 3.2282 | 164 | 88 | 76 | 204 | 2.69 | 54% | -16 | 3.2 |
| 3.2941 | 3.1953 | 164 | 64 | 100 | 309 | 3.10 | 39% | -23 | 5.5 |
| 3.2612 | 3.1623 | 125 | 46 | 79 | 313 | 3.97 | 37% | -20 | 6.7 |
| 3.2282 | 3.1294 | 93 | 32 | 60 | 316 | 5.22 | 35% | -16 | 7.0 |

Source: J.P. Morgan

# Agenda



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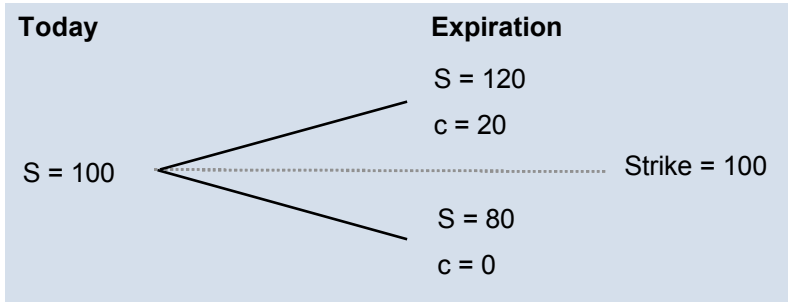
# HOW TO PRICE AN OPTION: ARBITRAGE-FREE PRICING

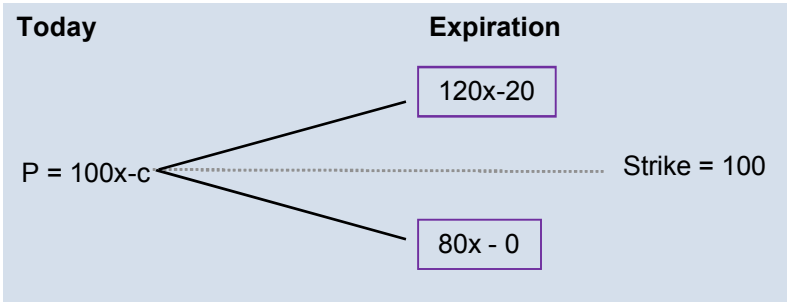
- As a trader, assume you are **short** (i.e. you sell) a **call**. How would you structure a portfolio (one short call + *x* units of stock) such that you are *perfectly hedged in both up and down scenarios*?

**Outcomes for the stock process**




Source: J.P. Morgan

**Delta-Hedged portfolio: P = xS-c**




Source: J.P. Morgan

- To be *perfectly hedged*: 120x-20 = 80x, or **x = 0.50**. i.e. buy 1/2 a share of stock. In both up and down scenarios, portfolio payoff = $40. **The portfolio is thus riskless**, assured of a $40 payoff irrespective of the state of the world.

- **A riskless portfolio should earn the riskless rate of interest (no-arbitrage condition).** Thus, the PV of the portfolio is the **discounted** value of the portfolio value at expiry, at the risk-free rate (1% in our example):
  - 100x0.5 – c = $40 / (1+0.01)
  - Thus, c = $10.39

**NO PROBABILITIES WERE NECESSARY – ONLY THE "NO ARBITRAGE" PRINCIPLE IS NEEDED**

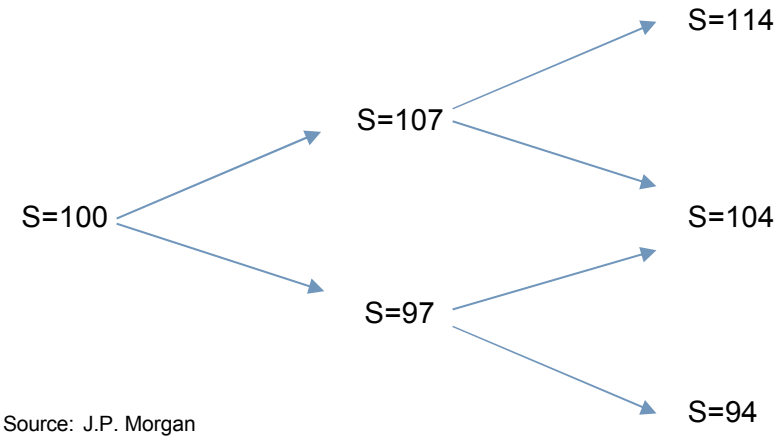
## RISK-NEUTRAL PROBABILITIES DERIVED FROM OPTION PRICES

Although no probabilities are required for pricing options, "risk-neutral" probabilities may be estimated

- A "risk-neutral" world is one where investors care only about expected returns, not the risk associated with earning these returns
- **In a risk-neutral world, <u>all assets will earn the risk-free rate</u>**
- Let:
  - p = probability of an up move
  - q = 1-p = probability of a down move
  - r = risk-free interest rate
- **$S_0 = \{ S_{\_up}\, p + S_{\_down}\, q \} / (1 + r)$**
  - **In our example $S_0 = 100$, $S_{\_up} = 120$, $S_{\_down} = 80$, r = 1%**
  - **p = 0.525; q = 0.475**
- Since the **call option also earns the riskless rate of return**, its value is the discounted value of the expected payoff:
  - call premium = (**0.525** * $20 + **0.475** * $0) / 1.01 = $10.39
- Risk-neutral probabilities are a mathematical trick that provides an intuitive way to price options. **Our intuitive valuation of options as the discounted value of expected payoffs is true when using so-called "risk-neutral" probabilities**

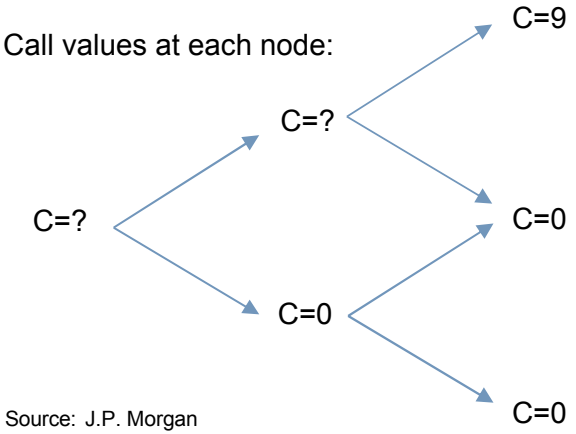
# PRICING BY BACKPROPAGATION: STARTING FROM TERMINAL PAYOFFS

Scenario: The Governor sets the price of an asset S at every step, by flipping a fair coin.
What is the price of a 105 call option expiring in 2 periods, if interest rate is 0?



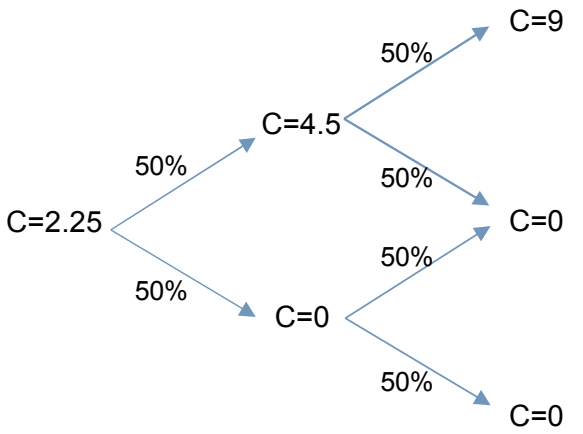

Source: J.P. Morgan

Call values at each node:



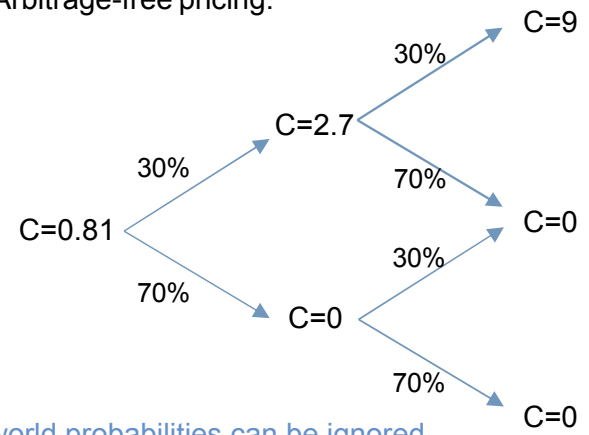

Source: J.P. Morgan

Naïve application of 50/50 real-world probabilities:




Source: J.P. Morgan

Arbitrage-free pricing:




Real-world probabilities can be ignored when the underlying asset is tradeable

Source: J.P. Morgan





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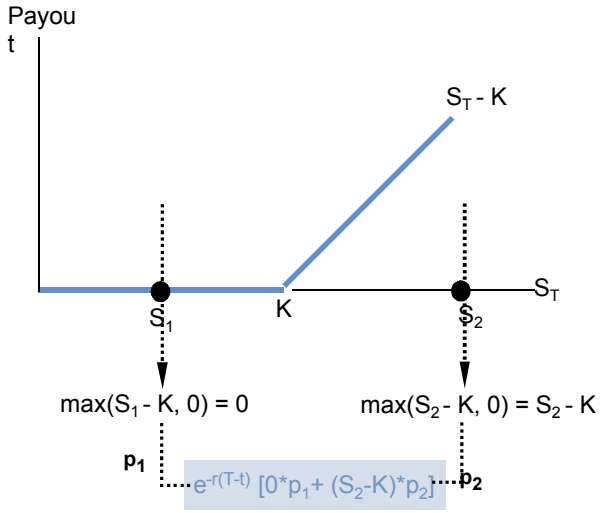
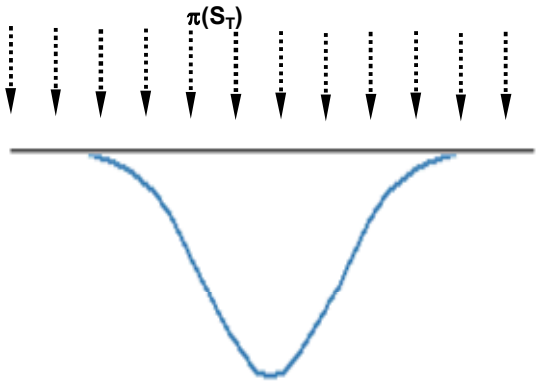
# BLACK SCHOLES OPTION PRICING

## Risk-neutral option pricing in a two-state world




Source: J.P. Morgan

## Risk-neutral option pricing in a continuous world




$c = e^{-rT}\,[\Sigma p_i * \max(S_i - K, 0)]$ $= e^{-r(T-t)} \int_K^\infty (S_T - K)\pi(S_T)\,dS_T$

Source: J.P. Morgan

## Notations

- $S_0$ = Spot rate at inception (expressed in Asset / Numeraire , or Foreign Ccy /Domestic Ccy)
- $K$ = Strike
- $T$ = Time to maturity in years
- $r_f$ = Asset (foreign) ccy interest rate (not in original BS)
- $r_d$ = Numeraire (domestic) ccy interest rate
- $\sigma$ = Volatility (in %, annualized)

## FX Option Pricing Formulas

### Price of a Call option

$$c = S_0 \exp(-r_f T)\mathbb{N}(d_1) - K \exp(-r_d T)\mathbb{N}(d_2)$$

### Price of a Put option

$$p = K \exp(-r_d T)\mathbb{N}(-d_2) - S_0 \exp(-r_f T)\mathbb{N}(-d_1)$$

where

- $d_1 = \dfrac{\ln(S_0/K) + (r_d - r_f + \sigma^2/2)T}{\sigma\sqrt{T}}$
- $d_2 = d_1 - \sigma\sqrt{T}$
- N(*z*) is the normal cdf given by $\dfrac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{z^2}{2}}\,dz$





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# OPTION IMPLIED DISTRIBUTIONS ON BLOOMBERG

## FXFM

98) Recalculate | 99) References | FX Rate Forecast Model

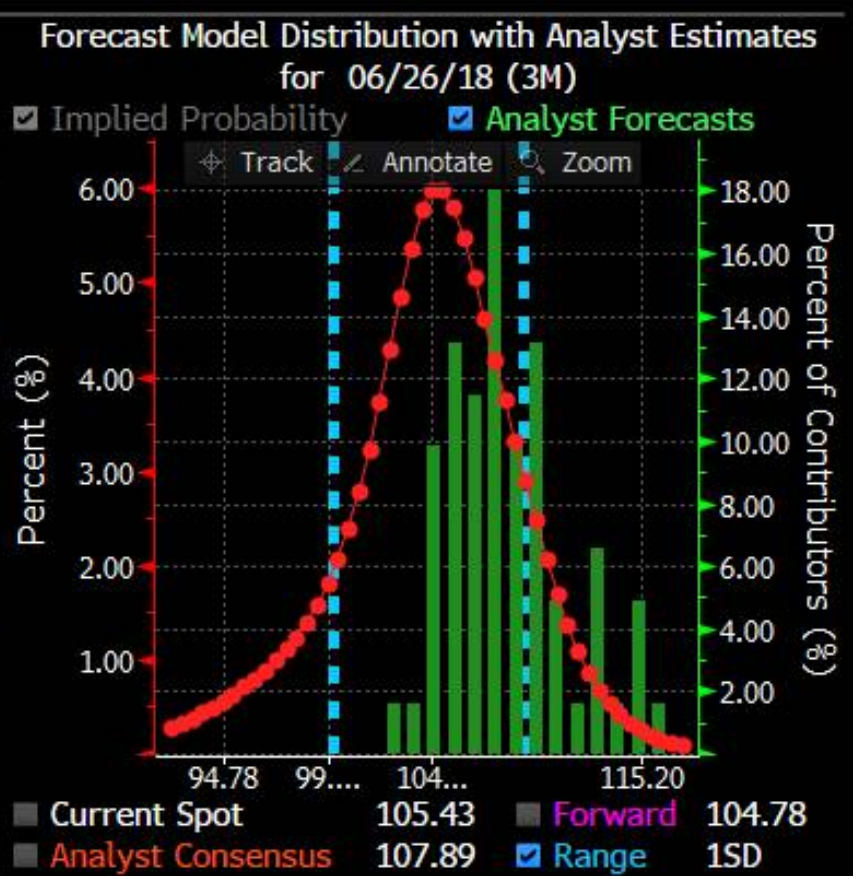
96) Overview | 97) Probability Calculator

USDJPY as of 03/26/18

Source Bloomberg BGN

Range 1 Standard Deviation

| | Date | Price Range | Prob |
|---|---|---|---|
| 1) 1W | 04/02/18 | 104.19 - 106.54 | 75.7% |
| 2) 1M | 04/25/18 | 102.66 - 107.76 | 72.9% |
| 3) 2M | 05/25/18 | 101.30 - 108.68 | 72.6% |
| 4) 3M | 06/26/18 | 100.14 - 109.43 | 72.8% |
| 5) Q2 18 | 06/30/18 | 99.94 - 109.51 | 72.8% |
| 6) 6M | 09/26/18 | 97.36 - 110.78 | 73.2% |
| 7) Q3 18 | 09/30/18 | 97.24 - 110.83 | 73.2% |
| 8) 9M | 12/26/18 | 94.96 - 111.72 | 73.5% |
| 9) Q4 18 | 12/31/18 | 94.82 - 111.68 | 73.4% |
| 10) 1Y | 03/26/19 | 92.85 - 112.21 | 74.1% |
| 11) Q1 19 | 03/31/19 | 92.72 - 112.23 | 74.1% |
| 12) 2019 | 12/31/19 | 87.27 - 112.74 | 74.3% |
| 13) 2Y | 03/26/20 | 85.72 - 112.77 | 74.4% |
| 14) 2020 | 12/31/20 | 81.06 - 112.36 | 74.7% |
| 15) 2021 | 12/31/21 | 75.68 - 111.41 | 74.9% |
| 16) | __/__/__ | - | |
| 17) | __/__/__ | - | |




Source: Bloomberg

## FACTORS AFFECTING OPTION VALUE – FIRST LOOK AT "THE GREEKS"

There are six factors that affect the value of an option at inception.
Here are the sensitivities of calls and puts to each of them:

| | European | | American | |
|---|---|---|---|---|
| **Factor** | **Call** | **Put** | **Call** | **Put** |
| Underlying Price (DELTA) | + | - | + | - |
| Strike | - | + | - | + |
| **Volatility (VEGA)** | **+** | **+** | **+** | **+** |
| Risk-Free Domestic Rate | + | - | + | - |
| Time to Maturity (THETA) | + | +/- | + | + |
| Foreign Interest Rate (equivalent to dividends for equity options) | - | + | - | + |

The key driver of option price

Can you think of a situation when increasing the time to maturity lowers the value of a put option?

Source: J.P. Morgan

# Agenda



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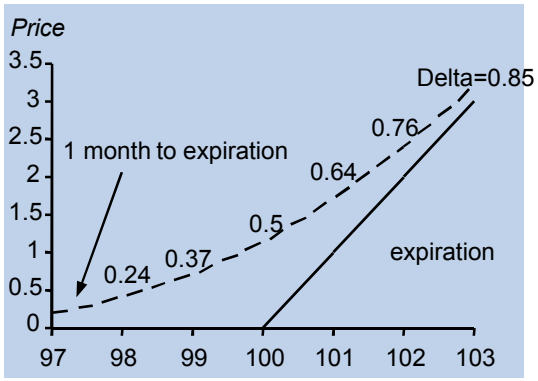
# DELTA

## Call Deltas

- Increase as the underlying price increases
- Can be interpreted as the probability that the option will finish in the money

**100 Call Option Premium (10% vol)**

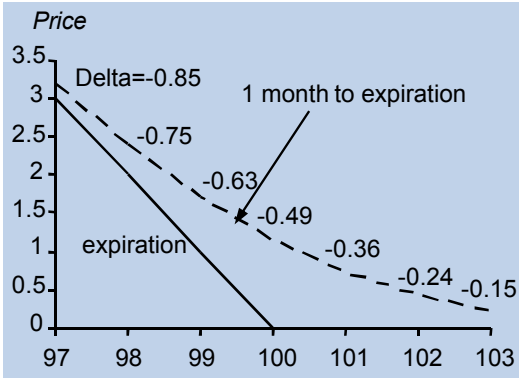



Source: J.P. Morgan

## Put Deltas

- Increase as the underlying price increases
- Can be interpreted as -1 times the probability that the option will finish in the money

**100 Put Option Premium (10% vol)**

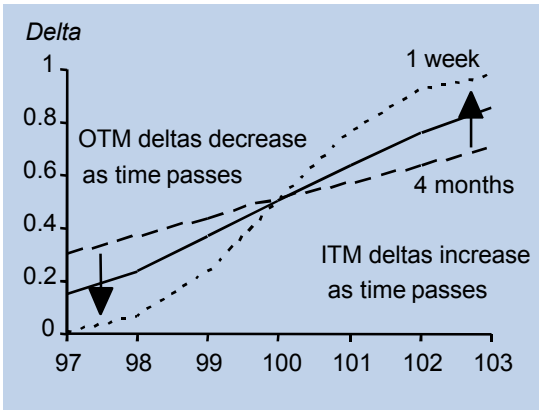



Source: J.P. Morgan

## As time passes,

- The delta of ITM options increases
- The delta of OTM options decreases

**100 Call Option Deltas (10% vol)**

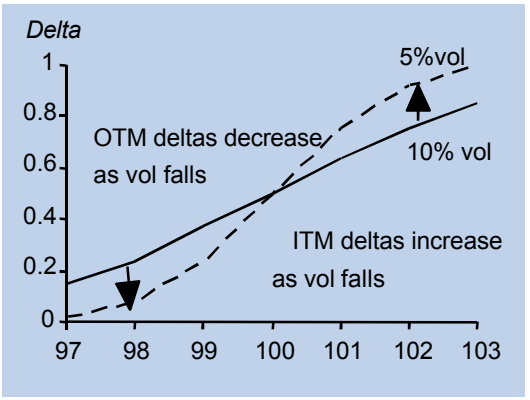



Source: J.P. Morgan

## As volatility falls,

- The delta of ITM options increases
- The delta of OTM options decreases

**100 Call Option Deltas (1 month)**




Source: J.P. Morgan

# DELTA S – BLACK-SCHOLES VS REAL ("ADAPTED")

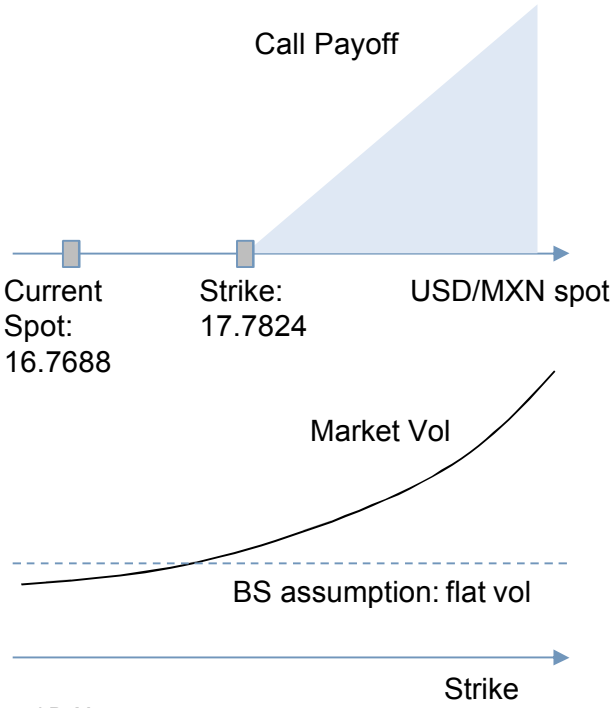
## Consider a 3M 25D Call on USD/MXN

Black-Scholes Delta is 25%.

Adapted Delta – the "real delta", thus the actual FX hedge, taking into account the shape of the vol smile, is lower (19%)

The opposite is true for the Put: real delta is larger than 25% in absolute value.

*Why?*




Source: J.P. Morgan

| | | |
|---|---|---|
| **FX Pair** | USD/MXN | USD/MXN |
| **Option Type** | Call on USD | Put on USD |
| **Expiration Date** | **Wed 16Dec2015 [92d]** | **Wed 16Dec2015 [92d]** |
| **Settlement Date** | Fri 18Dec2015 | Fri 18Dec2015 |
| **Strike** | **17.7824** | **16.1819** |
| **Settlement Type** | Physical | Physical |
| **Settlement Currency** | N/A | N/A |
| **Expiration Cut** | MXN | MXN |
| **Quantity Currency** | USD | USD |
| **Quantity** | 100,000,000 | 100,000,000 |
| **Buy/Sell** | b - JPM Buys | b - JPM Buys |
| **Spot** | **16.7688** | **16.7688** |
| **Forward** | 16.8848 | 16.8848 |
| **Forward Point** | 0.1160 | 0.1160 |
| **Denominated Depo** | 3.08 | 3.08 |
| **Asset Depo** | 0.34 | 0.34 |
| **Vol for strike** | **15.250** | **12.598** |
| **ATM Volatility** | 13.475 | 13.475 |
| **Premium Display** | % USD | % USD |
| **Price(%)** | **1.1665** | **0.9258** |
| **Price(Pips)** | **0.000656** | **0.000572** |
| **Edge Style** | Choice | Choice |
| **Edge (%)** | 0.000 | 0.000 |
| **BS+TS TV (%)** | **0.885** | **1.065** |
| **BS+TS TV (Pips)** | **0.000498** | **0.000658** |
| **+ PriceExtra** | | |
| **BS Delta (%)** | 25.00 | -25.00 |
| **BS Spot Delta (%)** | 24.98 | -24.98 |
| **BS Forward Delta (%)** | 25.00 | -25.00 |
| **Adapted Forward Delta (%)** | 19.10 | -26.70 |
| **Adapted Delta (%)** | **19.09** | **-26.67** |
| **Adapted Gamma (%)** | 3.17 | 6.10 |

Source: J.P. Morgan





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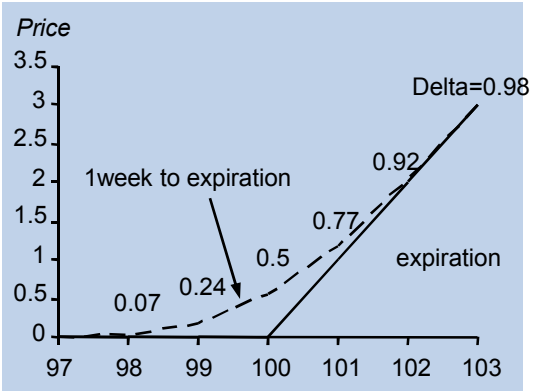
# GAMMA

*Gamma* is the change in delta for one unit move in the underlying.

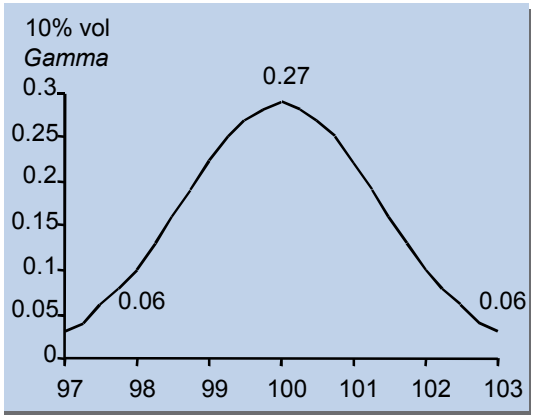
**100 Call Option Premium (10% vol)**




Source: J.P. Morgan

ATM options have the largest gamma.

**100 Call Option Gammas (1 week)**

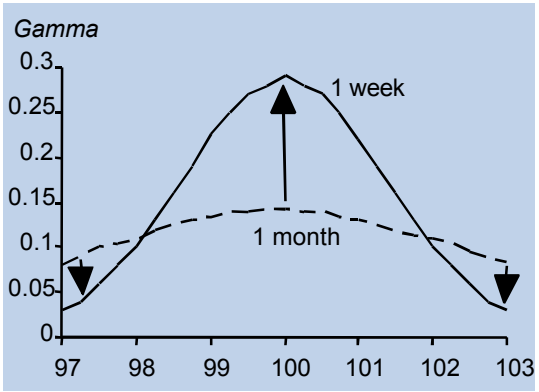



Source: J.P. Morgan

**As time passes,**

- The gamma of an ATM option increases
- The gamma of deep ITM and OTM options decreases

**100 Call Option Gammas (10% vol)**

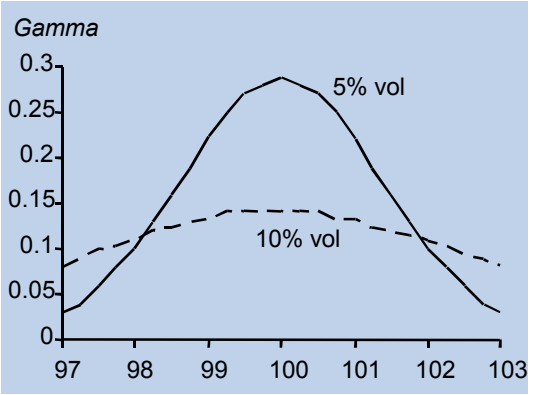



Source: J.P. Morgan

**As volatility falls,**

- The gamma of an ATM option increases
- The gamma of deep ITM and OTM options decreases

**100 Call Option Gammas (1 month)**

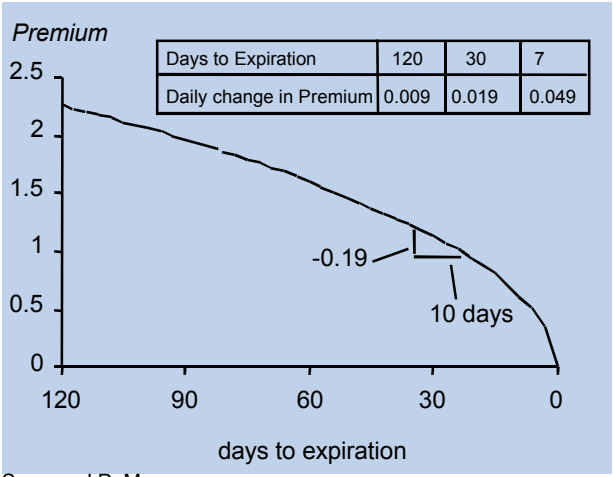



Source: J.P. Morgan

# THETA

*Theta* is the change in the value of an option with one day's passage of time.

**ATM Call Option Premium (10% vol)**

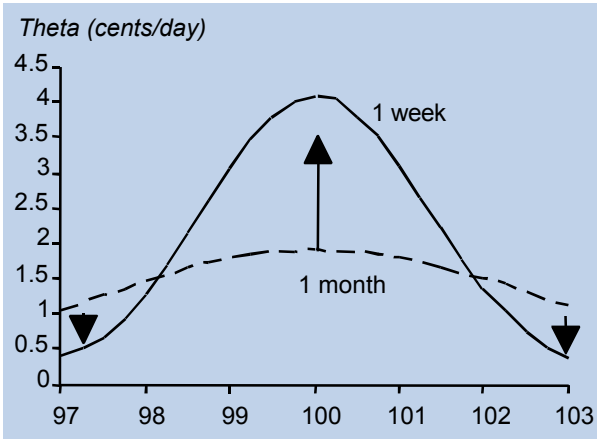



Source: J.P. Morgan

**As time passes,**

- The theta of an ATM option increases
- The theta of deep ITM and OTM options decreases

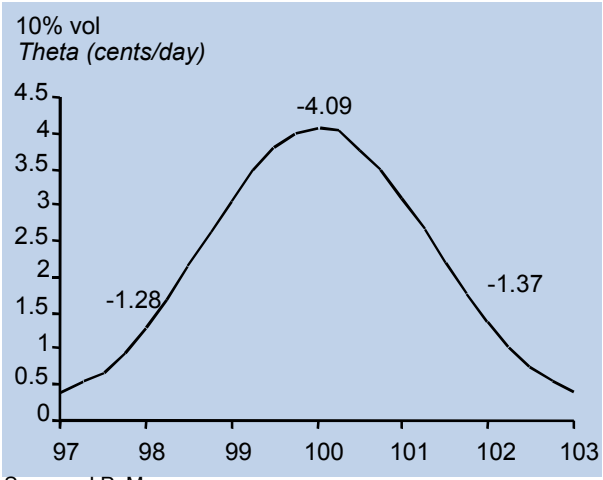
**100 Call Option Thetas (10% vol)**




Source: J.P. Morgan

ATM options have the largest time value and the largest theta.

**100 Call Option Thetas (1 week)**

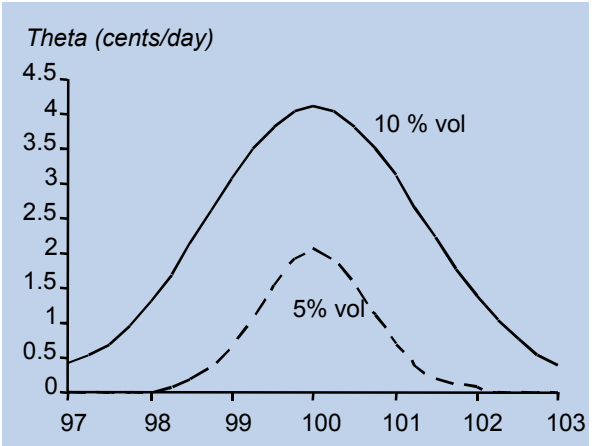



Source: J.P. Morgan

**As volatility falls,**

- Time value declines
- Theta declines

**100 Call Option Thetas (1 week)**




Source: J.P. Morgan





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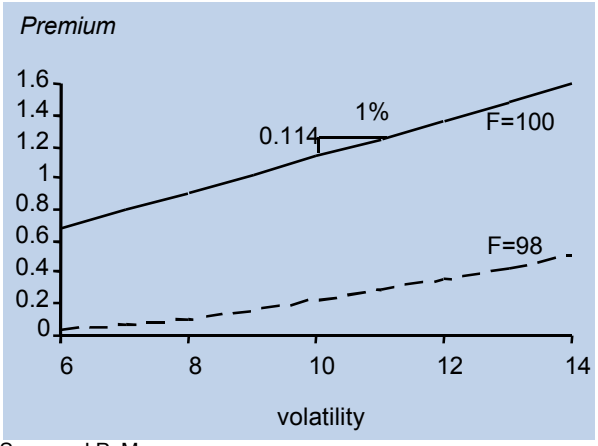
# VEGA

*Vega* is the change in the price of an option for a one percentage point increase in implied volatility.

**100 Call Option Premium (1 month)**

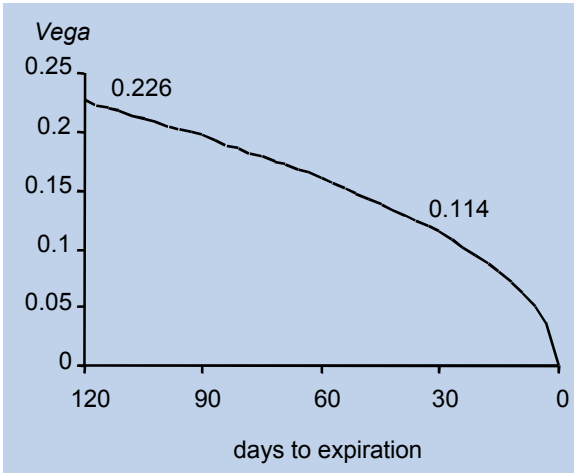



Source: J.P. Morgan

**As time passes,**

- vega decreases

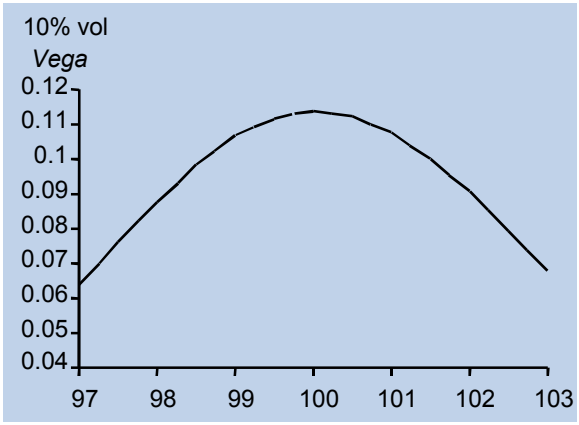
**ATM Call Option Vega (10% vol)**




Source: J.P. Morgan

ATM options have the largest vega.

**100 Call Option Vega (1 month)**

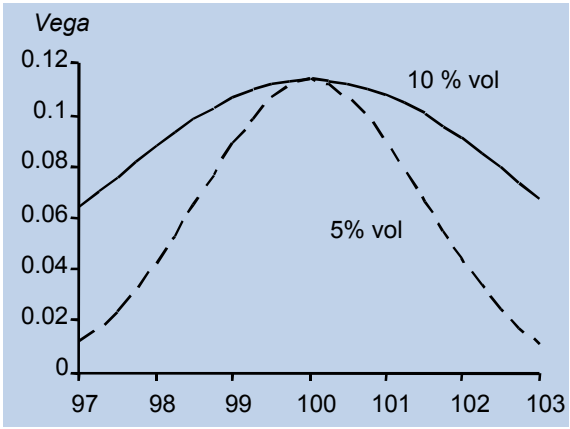



Source: J.P. Morgan

**As volatility falls,**

- Vega decreases for ITM and OTM options
- Vega is unchanged for ATM options

**100 Call Option Vega (1 month)**




Source: J.P. Morgan





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## PUTTING THE GREEKS TOGETHER

- Given the Greeks of an option, it is possible to decompose the one-period change in price of an option into the impact of different variables:

| | | |
|---|---|---|
| Delta P/L | = | Delta * Change in spot |
| Gamma P/L | = | (1/2) * Gamma * (Change in spot)$^2$ |
| Theta P/L | = | Theta * Time Elapsed |
| Vega P/L | = | Vega * Change in Implied Vol |
| Net P/L | = | Delta P/L + Gamma P/L + Theta P/L + Vega P/L |

- **Example:**

**Q.** You are long a 6M 99 strike USD call/JPY put. Spot is 98. The option Greeks are as follows: delta = 43, gamma = 5, theta = -2bp/day, vega = 28bp. What is the change in price of the option if spot USD/JPY rallied 1% over the next day, assuming that the volatility of the option declined 0.4 percentage points as a result?

**A.** Change in spot = 1% = 100bp

| | | |
|---|---|---|
| Delta P/L | = 0.43 * 100 | = 43.0bp |
| Gamma P/L | = (1/2) * (5) * (1)$^2$ | = 2.5bp |
| Theta P/L | = - 2bp/day * 1 day | = -2.0bp |
| Vega P/L | = 28 * -0.4 | = -11.2bp |
| **Net P/L** | | **= 32.3bp** |

## OPTION PORTFOLIOS

- A single long call option position has
  - Positive DELTA
  - Positive GAMMA
  - Negative THETA
  - Positive VEGA
- A single long put option position has
  - Negative DELTA
  - Positive GAMMA
  - Negative THETA
  - Positive VEGA
- For a portfolio of options, notional-weighted Greeks are additive. Suppose, a portfolio is long two options, in notionals $N_1$ and $N_2$
  - Portfolio Delta = $N_1$* Delta$_1$ + $N_2$*Delta$_2$
  - Portfolio Gamma = $N_1$* Gamma$_1$ + $N_2$*Gamma$_2$
  - Portfolio Theta = $N_1$* Theta$_1$ + $N_2$*Theta$_2$
  - Portfolio Vega = $N_1$* Vega$_1$ + $N_2$*Vega$_2$
- Can you construct option portfolios that are:
  - Delta-neutral but long gamma?
  - Positive delta but neutral-gamma?
  - Positive gamma but negative vega?

Hint: Greeks vary for different options of the same tenor / different strikes, and for options of the same strike / different tenors

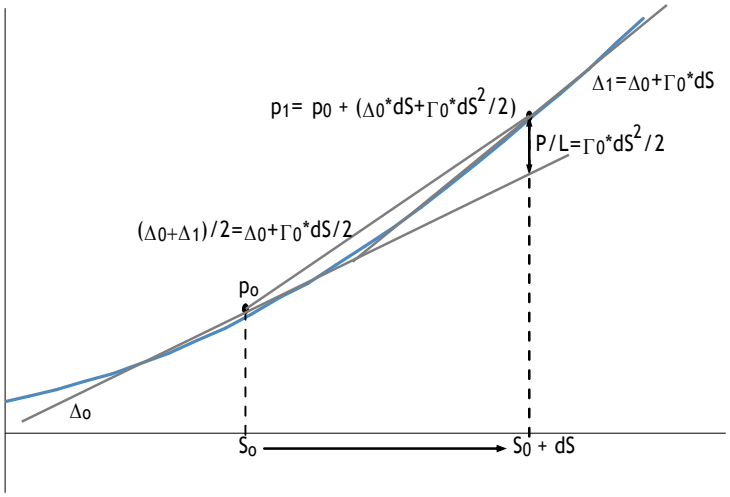
# BASICS OF GAMMA TRADING

$$\Delta p = \frac{\partial p}{\partial S}\Delta S + \frac{\partial p}{\partial \sigma}\Delta\sigma + \frac{\partial p}{\partial t}\Delta t + \frac{\partial p}{\partial r_H}\Delta r_H + \frac{\partial p}{\partial r_F}\Delta r_F + \frac{1}{2}\frac{\partial^2 p}{\partial S^2}\Delta S^2 + \ldots..$$

DELTA VEGA THETA RHO GAMMA

Note that P/L of the delta-hedged option depends ONLY on the **MAGNITUDE** of the spot move dS, not its direction (i.e. the sign). This is what is commonly referred to as volatility trading.

## Gamma P/L from delta hedging an option




Source: J.P. Morgan

## Net P/L from delta hedging an option

- Assuming constant volatility, P/L in one time step $\Delta t$ is given by

$$\frac{1}{2}\Gamma(\Delta_S)^2 + \Theta(\Delta_t)$$

- If interest rate **r** is assumed to be zero, then algebraic manipulation of the expressions for gamma and theta shown alongside yields the following relationship:

$$\Theta = -\frac{1}{2}\Gamma S^2\sigma^2$$

- The one step P/L expression above then simplifies to:

$$\frac{1}{2}\Gamma S^2\left[\left(\frac{\Delta S}{S}\right)^2 - \sigma^2(\Delta t)\right]$$

## Gamma Trading: From Math to English

$$\frac{1}{2}\sum_{i=1}^{N}\left[\left(\frac{\Delta S_i}{S_i}\right)^2\right]$$ **realized variance**

**$\sigma^2$** is called **implied variance**

The net P/L of a long delta-hedged option > 0 when **realized variance is greater than implied variance**.





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# DELTA-HEDGING – A PRACTICAL EXAMPLE

## 1M Call option delta hedged to maturity

Currency Pair : USD/JPY  Strike : 112.66
Option Type : USD call / JPY put  Option Notional : $100,000,000

| Day | USD/JPY Spot | Option Strike | Option Delta (%) | Option Gamma | Option Vega (bp USD) | Vol for strike (%) | Option Price (bp USD) | Option P/L (USD) | Delta Hedge Position | Hedge Transaction | Hedge P/L (USD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 112.74 | 112.66 | 50.2 | 12.2 | 12 | 10.6 | 134 | 0 | 50,200,000 | Sell 50,200,000 USD | 0 |
| 1 | 109.37 | 112.66 | 19.6 | 10.6 | 9 | 11.3 | 38 | -960,800 | 19,620,000 | Buy 30,580,000 USD | 1,499,550 |
| 2 | 109.15 | 112.66 | 18.4 | 9.6 | 8 | 11.6 | 35 | -23,900 | 18,410,000 | Buy 1,210,000 USD | 40,398 |
| 3 | 107.84 | 112.66 | 11.3 | 4.9 | 5 | 12.1 | 20 | -155,000 | 11,320,000 | Buy 7,090,000 USD | 221,180 |
| 4 | 108.35 | 112.66 | 12.7 | 6.1 | 6 | 12.1 | 22 | 17,200 | 12,690,000 | Sell 1,370,000 USD | -53,968 |
| 5 | 109.38 | 112.66 | 16.3 | 9.4 | 7 | 10.8 | 26 | 42,900 | 16,290,000 | Sell 3,600,000 USD | -120,775 |
| 6 | 109.23 | 112.66 | 14.7 | 8.5 | 6 | 10.8 | 22 | -35,100 | 14,720,000 | Buy 1,570,000 USD | 22,712 |
| 7 | 109.22 | 112.66 | 13.5 | 7.9 | 5 | 10.5 | 19 | -33,100 | 13,460,000 | Buy 1,260,000 USD | 579 |
| 8 | 108.77 | 112.66 | 11.0 | 6.0 | 5 | 10.9 | 15 | -38,200 | 11,000,000 | Buy 2,460,000 USD | 56,478 |
| 9 | 107.79 | 112.66 | 6.9 | 4.0 | 3 | 12.0 | 9 | -62,600 | 6,850,000 | Buy 4,150,000 USD | 98,344 |
| 10 | 106.62 | 112.66 | 3.1 | 2.2 | 2 | 12.2 | 4 | -54,200 | 3,080,000 | Buy 3,770,000 USD | 74,294 |
| 11 | 106.57 | 112.66 | 3.4 | 2.2 | 2 | 12.9 | 4 | 5,500 | 3,400,000 | Sell 320,000 USD | 1,540 |
| 12 | 106.94 | 112.66 | 3.7 | 2.5 | 2 | 12.7 | 4 | 2,700 | 3,720,000 | Sell 320,000 USD | -11,926 |
| 13 | 106.90 | 112.66 | 3.6 | 2.4 | 2 | 13.0 | 4 | -2,100 | 3,570,000 | Buy 150,000 USD | 1,548 |
| 14 | 105.69 | 112.66 | 1.8 | 1.4 | 1 | 15.0 | 2 | -20,800 | 1,840,000 | Buy 1,730,000 USD | 40,529 |
| 15 | 106.72 | 112.66 | 2.6 | 1.9 | 1 | 14.2 | 3 | 7,000 | 2,590,000 | Sell 750,000 USD | -17,925 |
| 16 | 105.62 | 112.66 | 0.8 | 0.8 | 0 | 14.2 | 1 | -20,100 | 820,000 | Buy 1,770,000 USD | 26,581 |
| 17 | 106.60 | 112.66 | 1.5 | 1.3 | 1 | 13.9 | 1 | 5,900 | 1,460,000 | Sell 640,000 USD | -7,584 |
| 18 | 107.14 | 112.66 | 1.4 | 1.3 | 1 | 13.2 | 1 | -1,500 | 1,440,000 | Buy 20,000 USD | -7,425 |
| 19 | 106.71 | 112.66 | 0.9 | 0.9 | 0 | 15.3 | 1 | -5,100 | 860,000 | Buy 580,000 USD | 5,779 |
| 20 | 106.88 | 112.66 | 0.5 | 0.6 | 0 | 14.7 | 0 | -3,400 | 490,000 | Buy 370,000 USD | -1,361 |
| 21 | 107.31 | 112.66 | 0.5 | 0.7 | 0 | 14.8 | 0 | 100 | 530,000 | Sell 40,000 USD | -1,963 |
| 22 | 106.29 | 112.66 | 0.0 | 0.1 | 0 | 14.4 | 0 | -3,100 | 30,000 | Buy 5000 USD | 5,042 |
| 23 | 106.31 | 112.66 | 0.0 | 0.0 | 0 | 12.0 | 0 | -100 | 0 | Buy 30,000 USD | -8 |
| 24 | 106.77 | 112.66 | 0.0 | 0.0 | 0 | 16.2 | 0 | 0 | 0 | Sell 0000 USD | 0 |
| | | | | | | | | (1,337,800) | | | 1,871,618 |

Because we delta-hedge the option to maturity, and the option expires worthless, naked option P/L is exactly equal to initial option price multiplied by option notional

Realized volatility calculated using spot moves turns out to be 14.5 (more on this on the next slide), which is greater than the implied volatility of 10.6 at entry. No wonder then that buying gamma turns out to be a profitable venture.

| | | |
|---|---|---|
| Naked option P/L | = | (1,337,800) |
| Delta-Hedge P/L | = | 1,871,618 |
| Net Delta-Hedged Option P/L | = | **533,818** |

Source: J.P. Morgan

# Agenda



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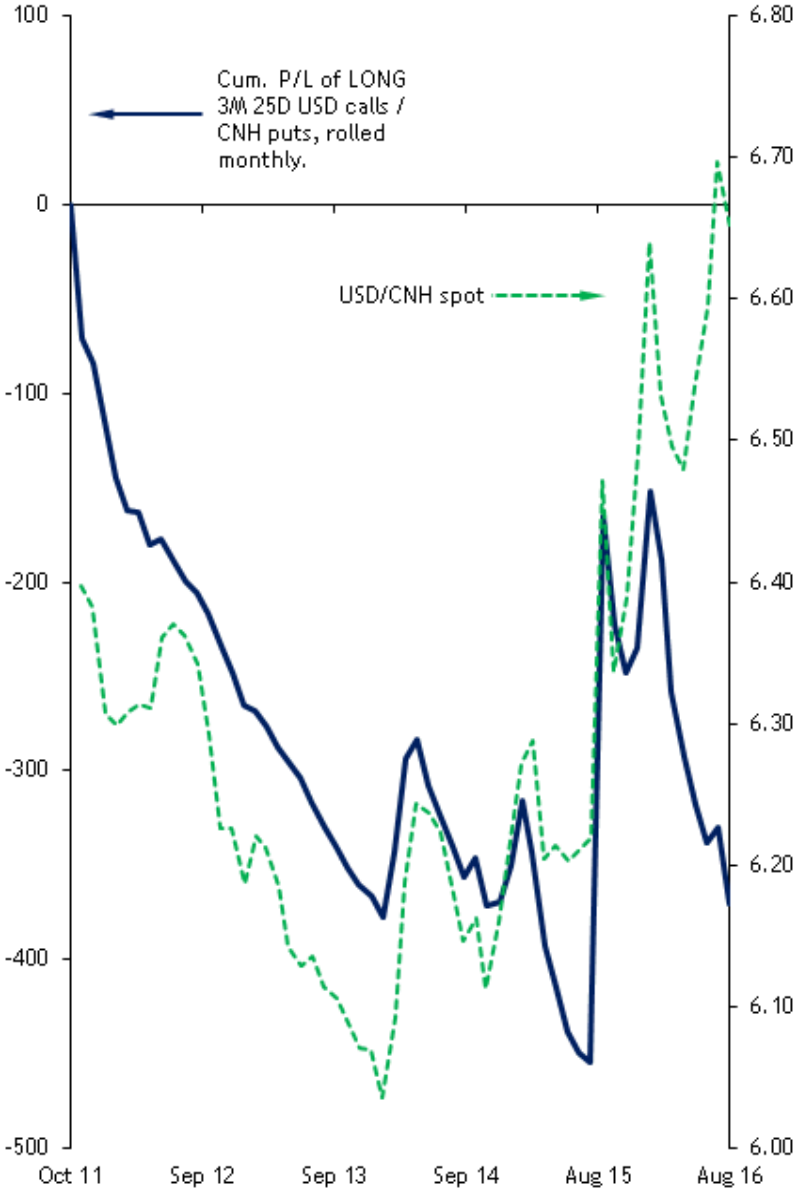
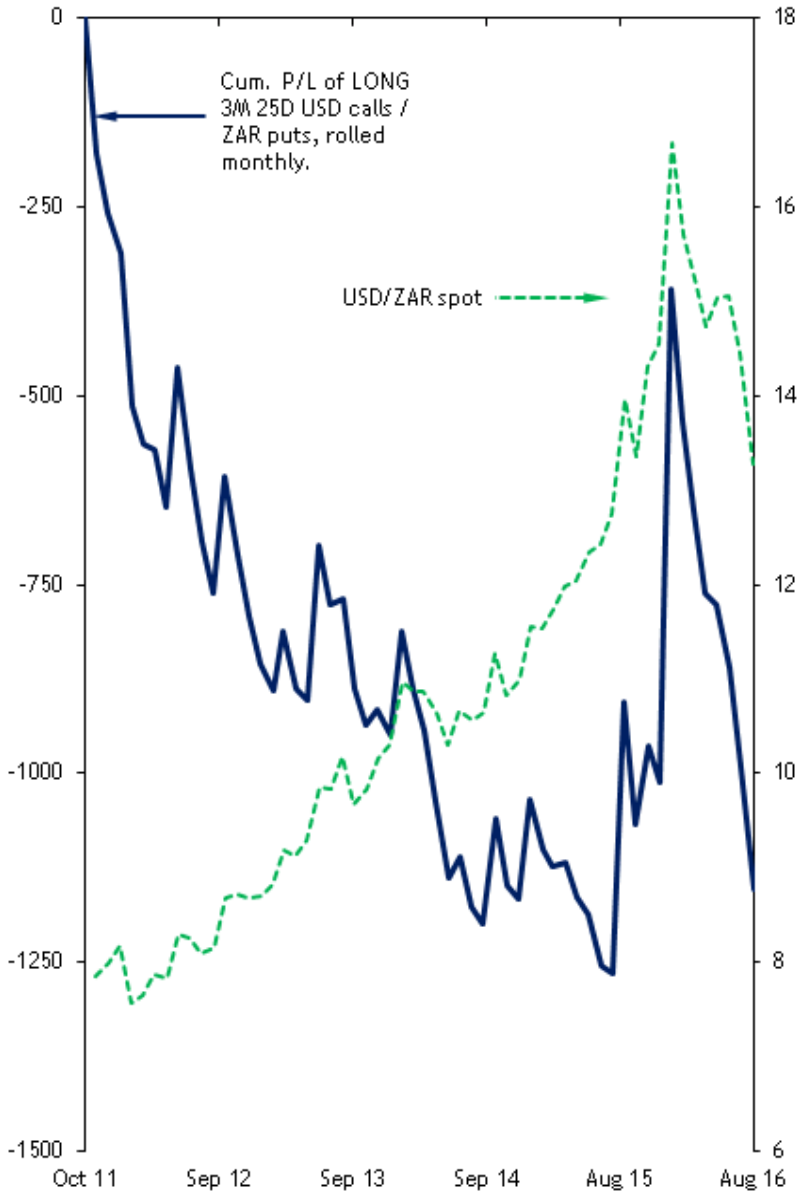
# BUYING OPTIONALITY: ATTRACTIVE IN THEORY, BUT……

*P/Ls in bp of USD notional*




Source: J.P. Morgan

*P/Ls in bp of USD notional*




Source: J.P. Morgan





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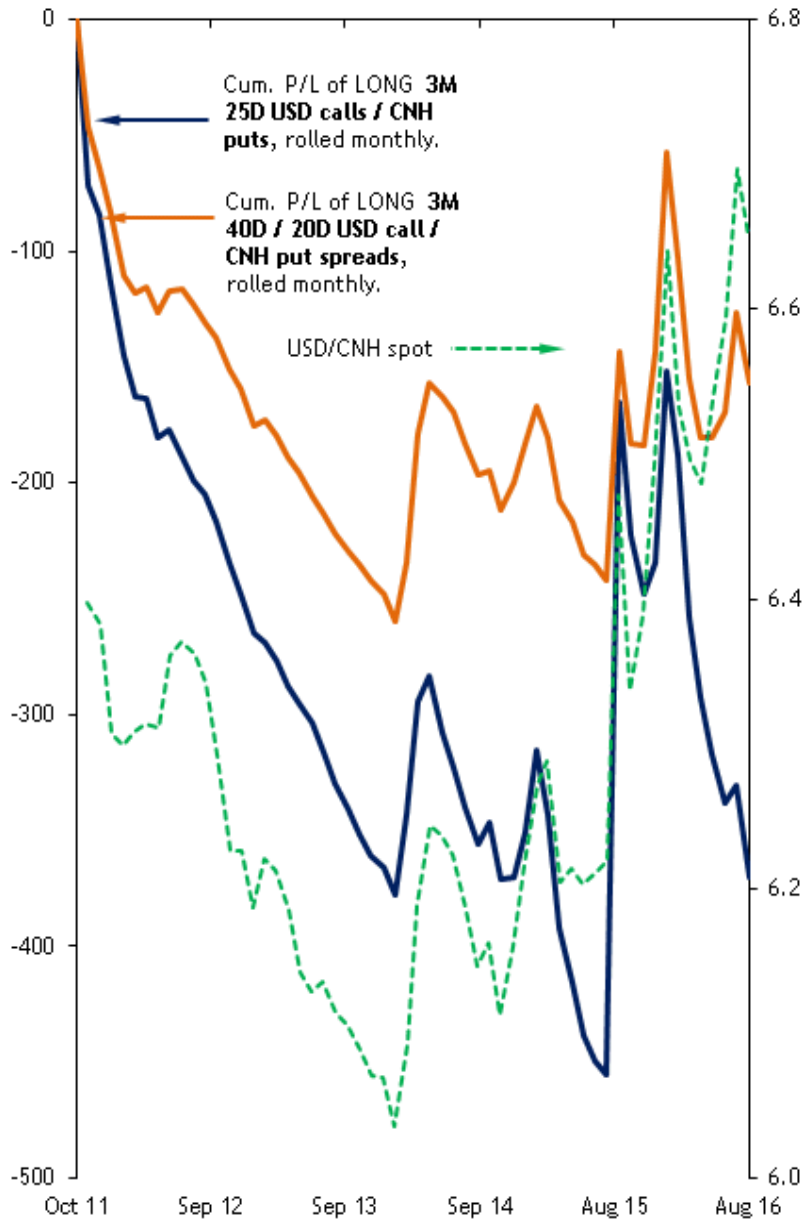
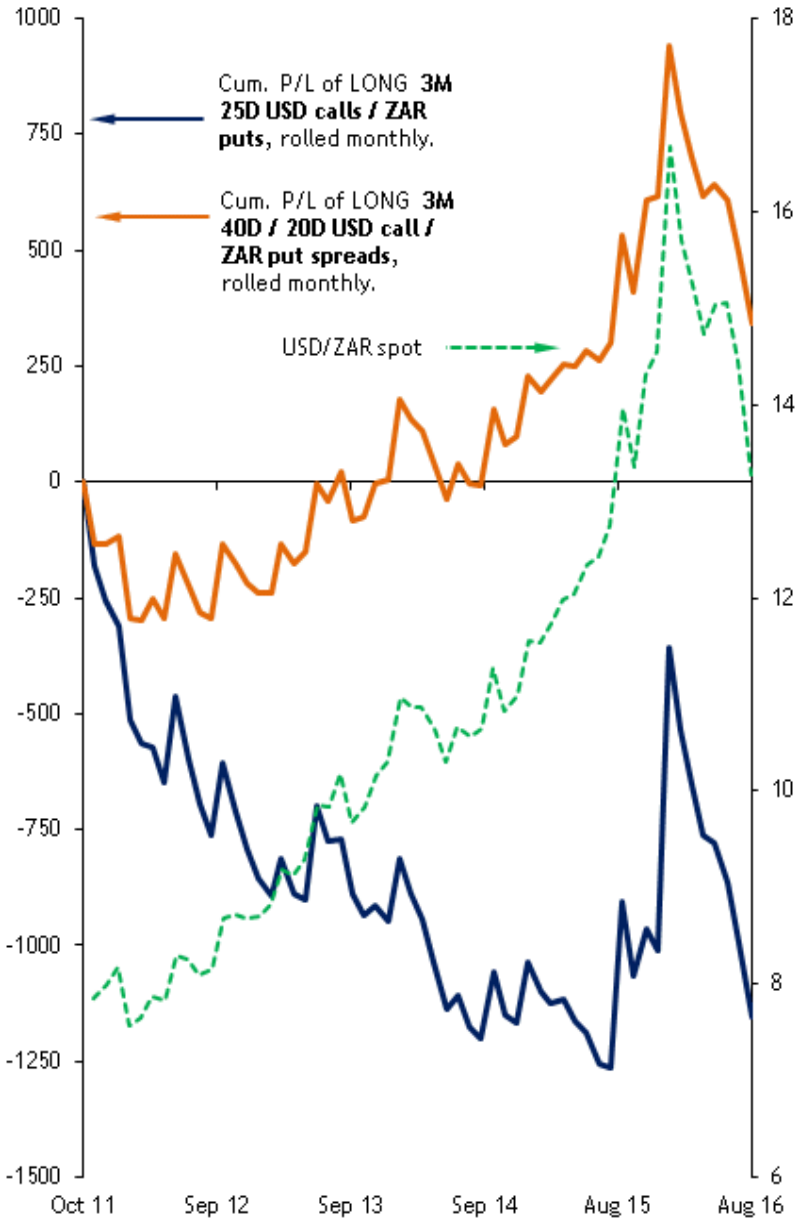
## BUYING PREMIUM / DECAY EFFICIENT OPTIONALITY DELIVERS FAR BETTER

*P/Ls in bp of USD notional*




Source: J.P. Morgan

*P/Ls in bp of USD notional*




Source: J.P. Morgan

DIRECTIONAL TRADING USING OPTIONS



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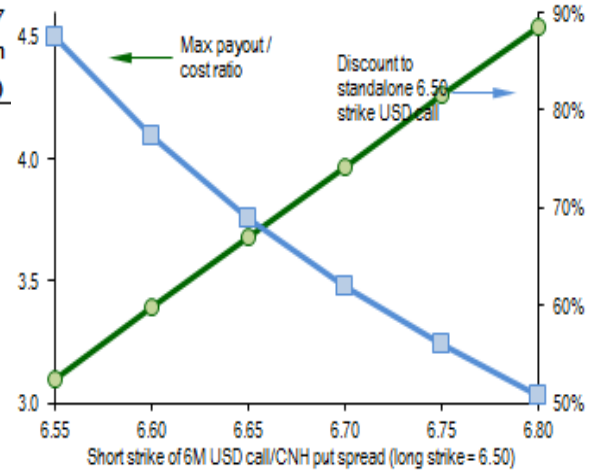
# UNDERSTANDING CALL/PUT SPREADS

## Trade-off 1: Leverage vs. discount to standalone long

| Spot ref. | 6.4017 |
|---|---|
| Strike | Premium (bp USD) |
| 6.40 | 266 |
| 6.40 | 266 |
| 6.45 | 228 |
| 6.50 | 197 |
| 6.55 | 173 |
| 6.60 | 153 |
| 6.65 | 136 |
| 6.70 | 122 |
| 6.75 | 110 |
| 6.80 | 100 |




Source: J.P. Morgan

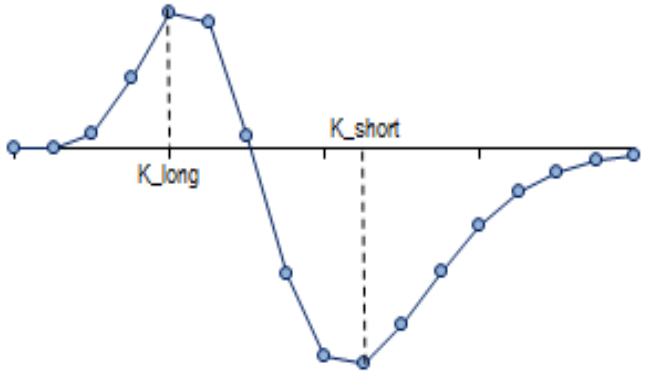
## Trade-off 2: *Ex-ante* optics vs. *ex-post* returns

**Beware of high leverage!** Typically coincides with trend extremes


Source: J.P. Morgan

## Beware the Greek sign flip

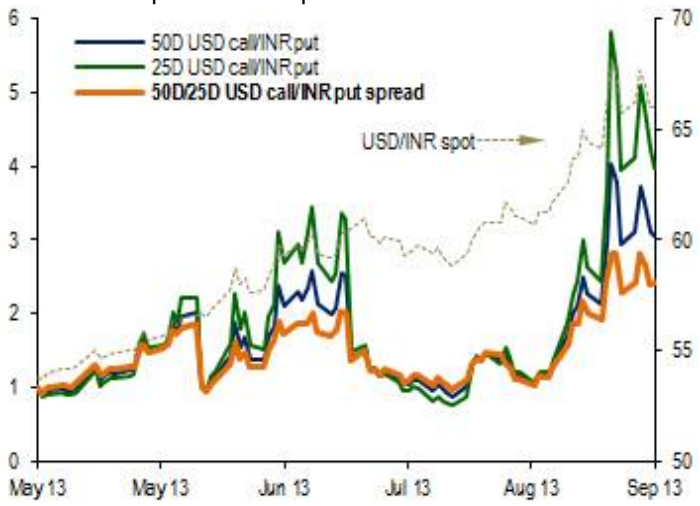
**Gamma/vega profile of a call spread vs. spot:** Long convexity flips to short as spot approaches the short strike




Source: J.P. Morgan

## Careful about spreads in the direction of spot explosion

**Return on premium** from ATM USD calls/INR puts, OTM USD calls /INR puts and ATM vs. OTM USD call/INR put spreads around the taper tantrum episode. No transaction costs.




Source: J.P. Morgan





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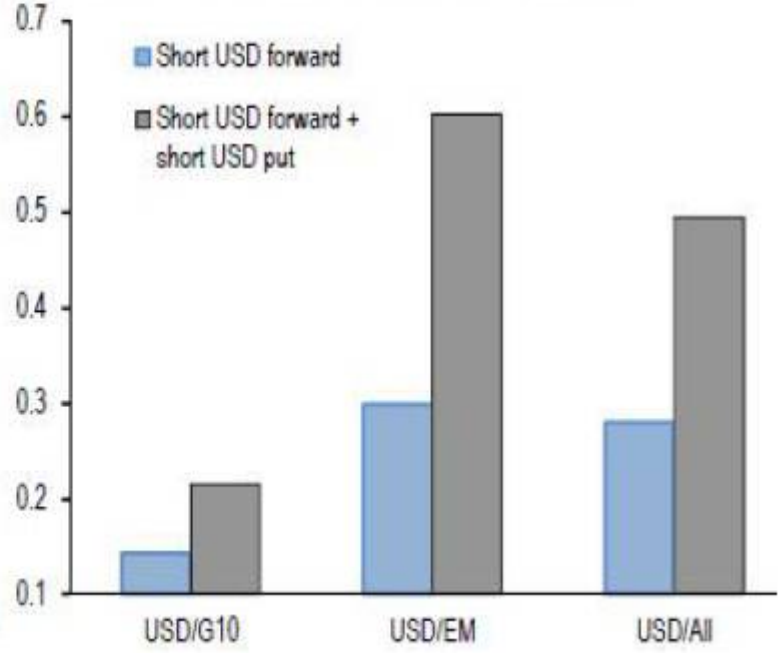
## SHORT USD PUT / EM FX CALL OVERLAYS ON LONG EM CASH A USEFUL STRATEGY

Drawdowns (bp USD) of ***average annual return equalized*** P/L streams of i) equally weighted portfolio of vshort 2M USD forwards vs. a basket of G10 and EM currencies; and (ii) same cash short USD portfolio + short 2M 25D USD puts/CCY calls in equal USD notionals. Forwards and options in all cases held for a month and rolled monthly. Assumes no transaction cost on forwards, and constant 0.3 and 0.5 mid-to-bid vol charges on G10 and EM options respectively.


Source: J.P. Morgan

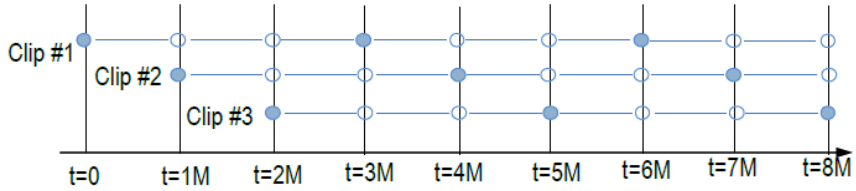
Average annualized return / average drawdown ratios of cash short dollars and short USD with USD put overwrite. Backtest details as in chart 2.




Source: J.P. Morgan

# Currency hedging with options

**Staggered forward / options hedging strategy**

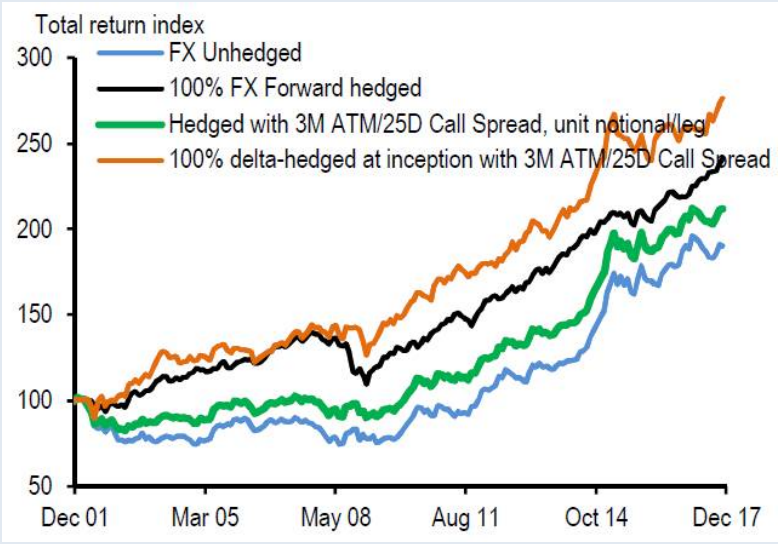



Source: J.P. Morgan

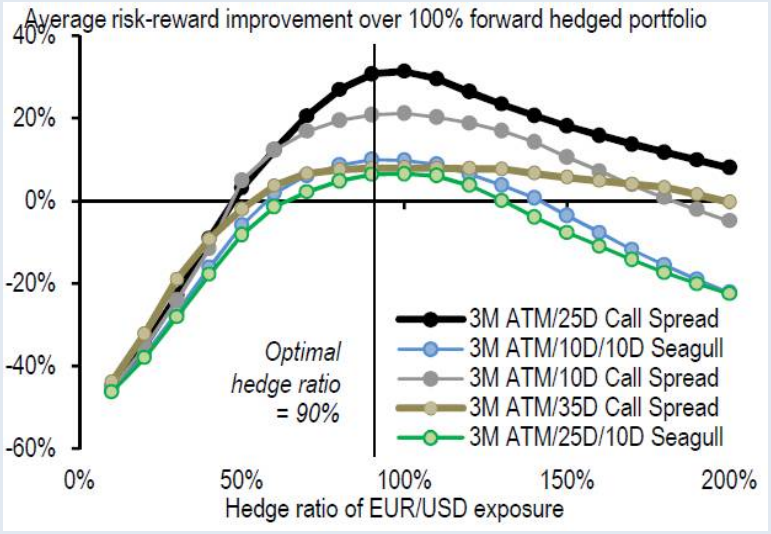
- The best option hedges can increase average portfolio returns by 50bp - 100bp annually over and above forward hedges
- EUR call spreads and seagull structures preferred hedging instruments
  - declines rather than rallies in EUR have been more volatile => lower velocity EUR strength well captured by limited upside structures such as call spreads and seagulls
- Preferred strikes are long ATM vs. short 25D or further OTM
- Preferred maturities are shorter (3M) rather than longer (6M or 1Y)
- In terms of notional sizing, matching option deltas to the underlying currency exposure is far more effective than matching option notionals

**https://www.jpmm.com/research/content/GPS-2622256-0**

**Cumulative returns of unhedged, FX forward hedged and FX option (3M ATM/25D call spread for EUR/USD) hedged US securities portfolios**




Source: J.P. Morgan




Source: J.P. Morgan





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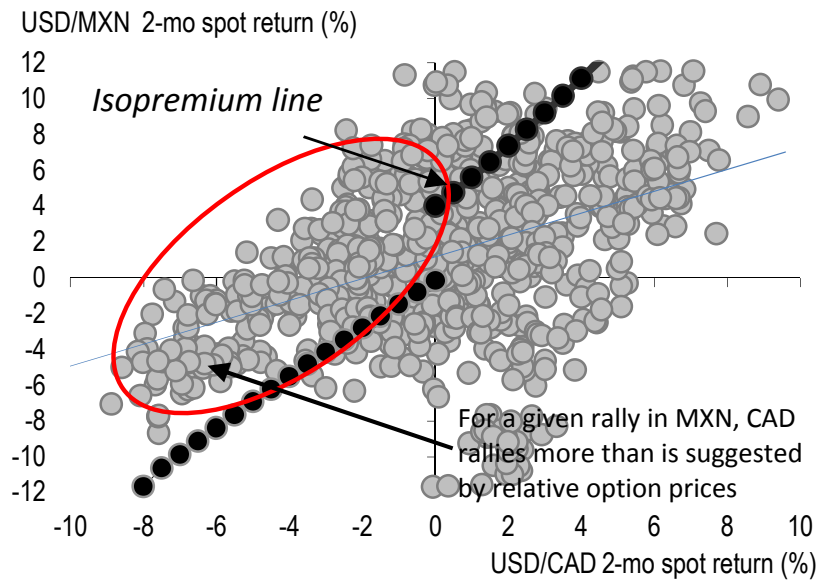
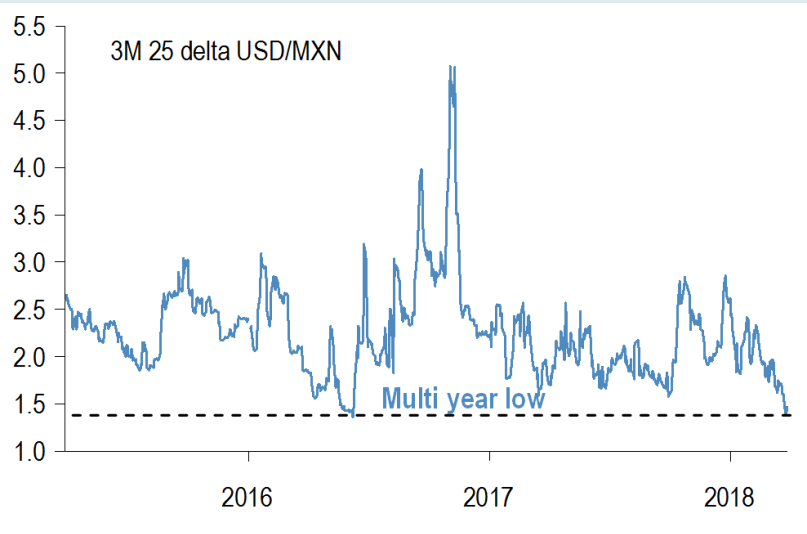
# Directional RV expression - Conditionals

- Relative value expression of buying ccy1/ccy2 cross
- Low (or zero) upfront premium commitment and little or no exposure to an anti-risk outcome
- The construct banks on relative mispricing of the two vol surfaces.
- *isopremium line* = a string of zero-option cost strikes (i.e. a pair of spot moves that are equally probable based on option market pricing)
- The scatter of past returns then illustrates how well option market prices their joint historical occurrence
- A highly asymmetric or lopsided set-up of the return scatter vis-à-vis the isopremium line indicates a potential mispricing in relative option prices.

*=> Buy 10wk USD/CAD puts 1.29 strike (spot 1.2886) vs. sell 10wk USD/MXN puts 18.18 strike (spot 18.1870), in equal notionals (not delta-hedged), premium-neutral*




Source: J.P. Morgan




Source: J.P. Morgan





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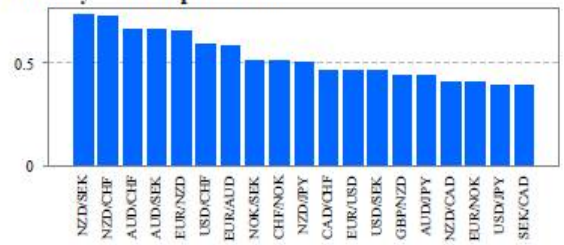
# ATMF vs. ATMS OPTION SPREADS FOR SYSTEMATIC CARRY TRADING

## Option-based carry report (ATMF, ATMF / ATMS)

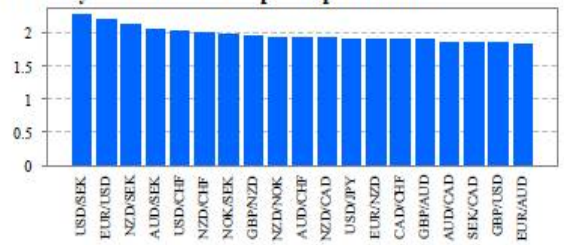
### G10

Avg. 1Y carry-by-vol ratio


1Y carry / ATMF price ratio



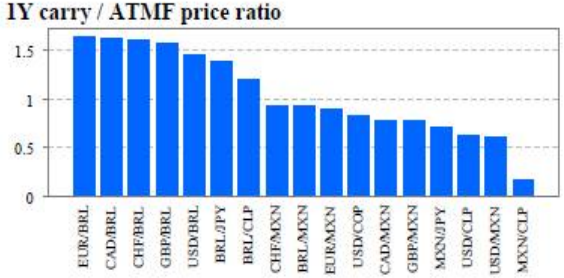

1Y carry / ATMF-ATMS spread price ratio



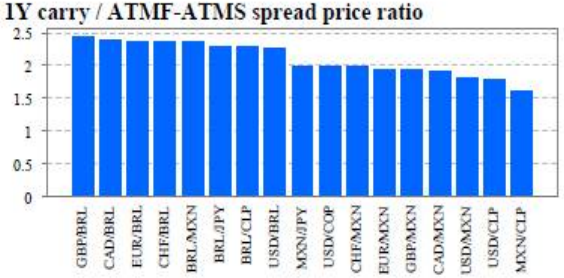

### LatAm

Avg. 1Y carry-by-vol ratio


1Y carry / ATMF price ratio



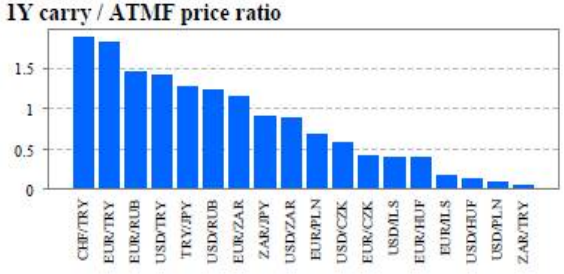

1Y carry / ATMF-ATMS spread price ratio



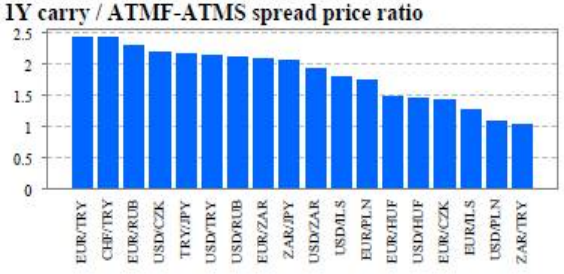

### Ceemea

Avg. 1Y carry-by-vol ratio


1Y carry / ATMF price ratio



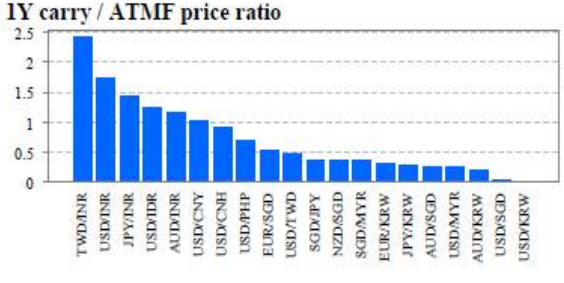

1Y carry / ATMF-ATMS spread price ratio



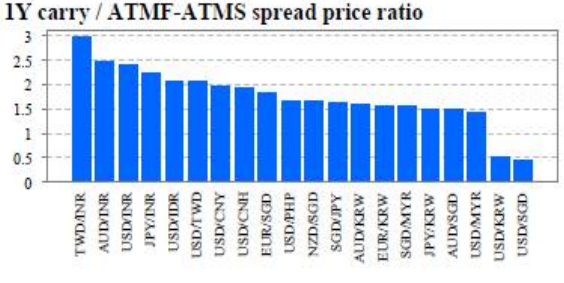

### Asia

Avg. 1Y carry-by-vol ratio


1Y carry / ATMF price ratio




1Y carry / ATMF-ATMS spread price ratio




Source: J.P. Morgan

# BASIC OPTION STRATEGIES CASE : CALL/ PUT SPREADS FOR TRADING CARRY

- **Carry** = P/L that can potentially accrue **if market conditions were to remain unchanged over the trade horizon**.
- In FX, carry trading = **buying high yielding currencies and selling low yielding currencies**, via forward transactions.
- Stands to pocket the difference between the two rates
- Example; USD/BRL:

Via fwds

- Spot (S) = 3.88 | $r_{BRL,3M}$ = 13.15% | $r_{USD,3M}$ = 0.35%
- Forward (F) = 3.88* [1+ 13.15% * (3/12)]/[1+0.35%*(3/12)]
  = 4.0055

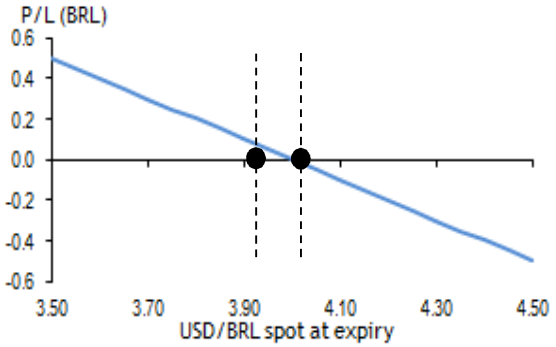
**The carry trade: sell 3M USD/BRL NDFs at 4.0055**

Via options

- **buy 3M ATMF (i.e. strike = forward = 4.0055) USD puts/BRL calls and sell 3M ATMS (i.e. strike = spot = ) USD puts/BRL calls**
- in the event of an adverse spot move, the downside from the put spread is floored at the option premium

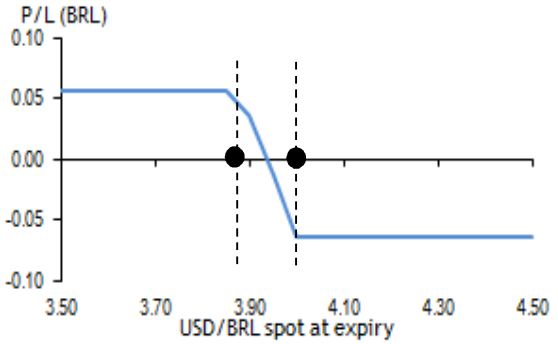
**Trading carry using USD/BRL forwards vs. options**

**Short USD/BRL NDF at 4.0055**



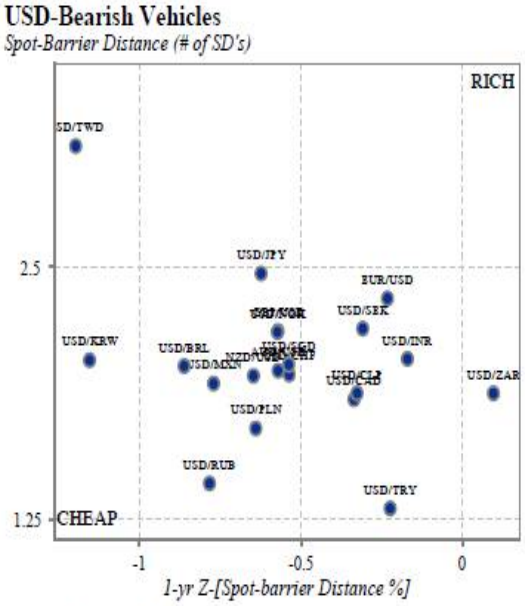

Source: J.P. Morgan

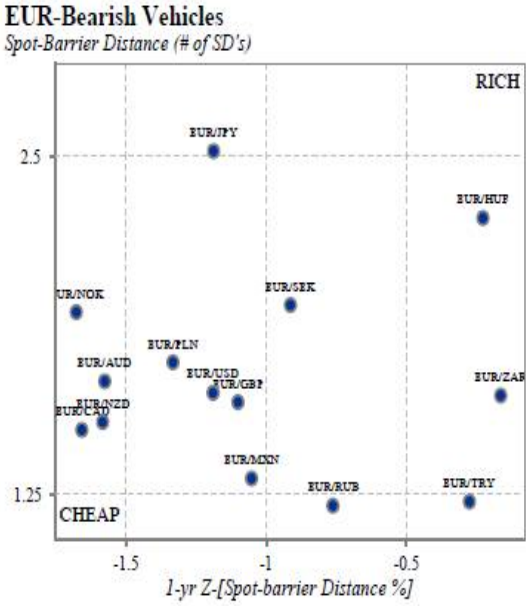
Short USD/BRL 4.0055 vs. 3.88 (ATMF / ATMS) put spread

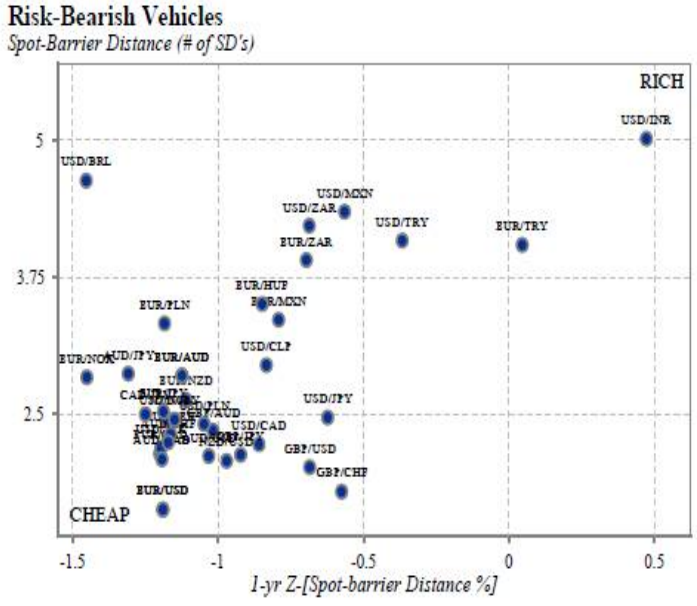


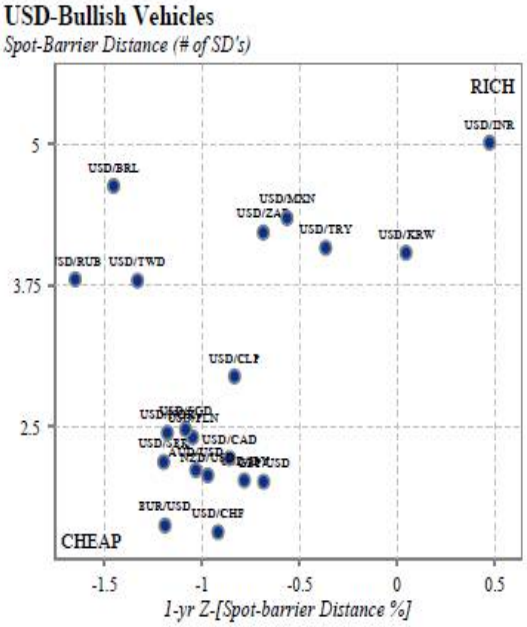

Source: J.P. Morgan

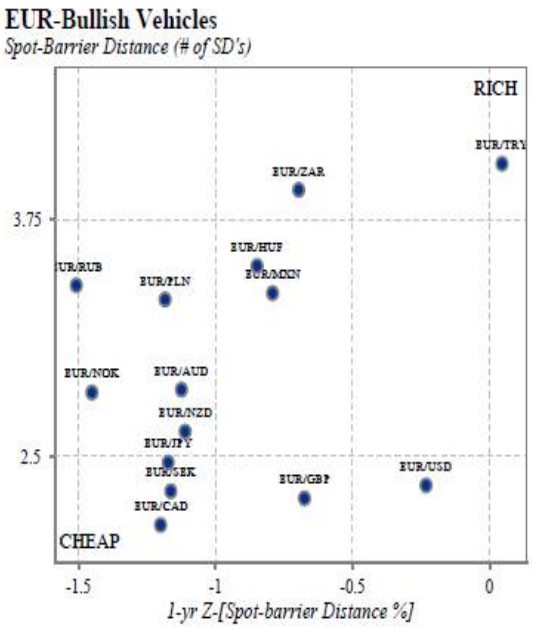
# ASSORTING DIRECTIONAL (ONE TOUCH) TRADES BY FX THEMES

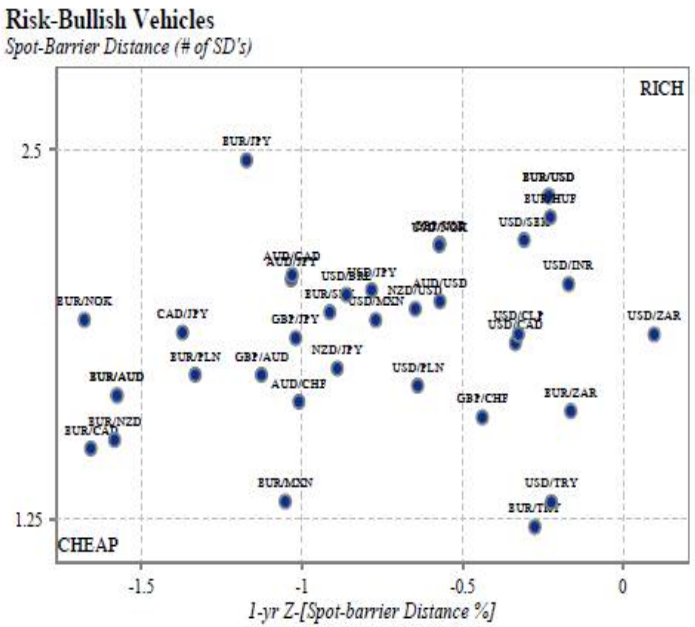



Source: J.P. Morgan



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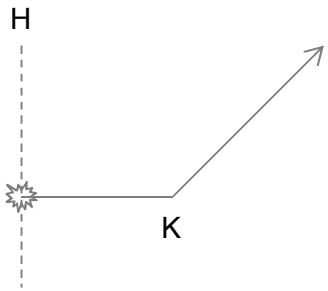
DIRECTIONAL TRADING USING OPTIONS

# Basic types of Barrier options

## Calls

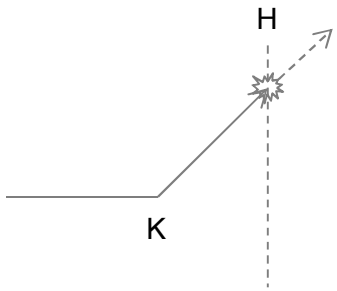
### Down-and-in or down-and out call




- Initially Spot > H
- KI call: spot must touch barrier H for OTM vanilla call to come to existence
- KO call: if spot touches barrier H OTM vanilla call knocked out (worthless)

Source: J.P. Morgan

### Up-and-in or up-and out call



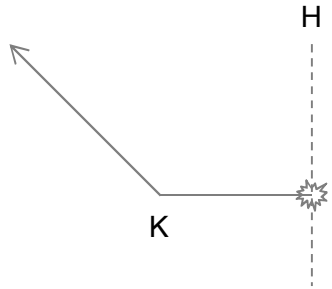

- Initially Spot < H
- RKI call: spot must touch barrier H for ITM vanilla call to come to existence
- RKO call: if spot touches barrier H ITM vanilla call knocked out (worthless)

Source: J.P. Morgan

* H designates the barrier level
** K designates the options strike

## Puts

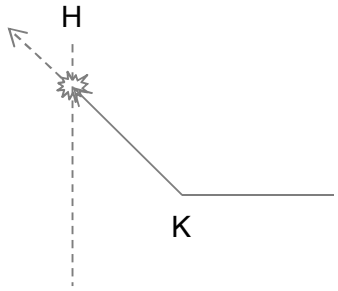
### Up-and-in or up-and out put




- Initially Spot < H
- KI put: spot must touch barrier H for OTM vanilla put to come to existence
- KO put: if spot touches barrier H OTM vanilla put knocked out (worthless)

Source: J.P. Morgan

### Down-and-in or down-and out put

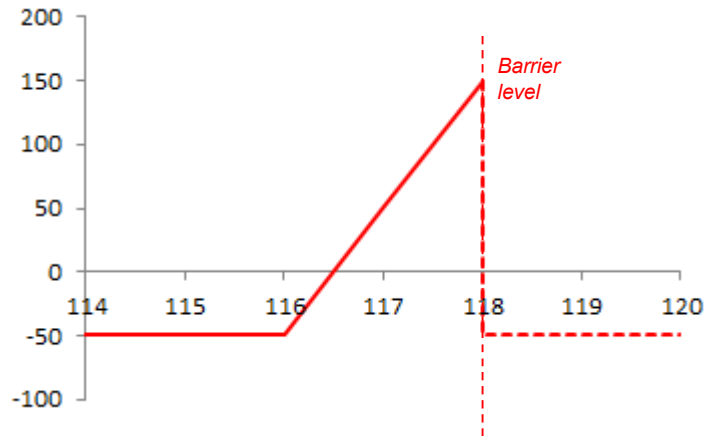



- Initially Spot > H
- RKI put: spot must touch barrier H for ITM vanilla putto come to existence
- RKO put: if spot touches barrier H ITM vanilla put knocked out (worthless)

Source: J.P. Morgan

# Reverse knock-outs and knock-ins

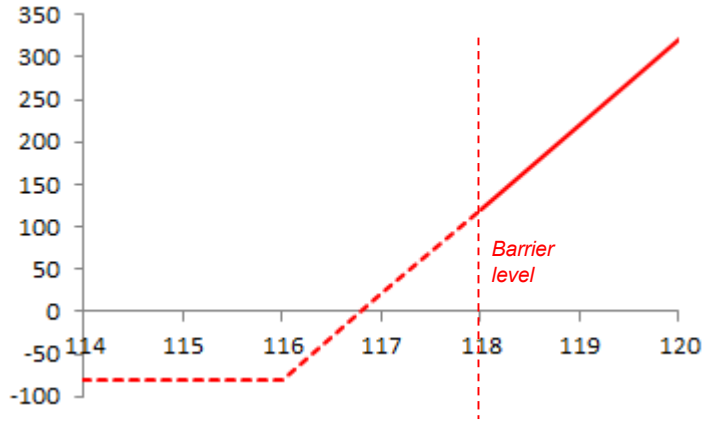
**Reverse Knock-out Call/Put**




Source: J.P. Morgan

- ***in-the-money*** when triggered => substantially lower premia than vanilla options.
- expresses a view on contained spot moves
- Used when:
  - spot positions crowded => spot grinds;
  - in anticipation of central bank intervention to slow / smooth spot moves;
  - when out-of-the-money strikes are expensive so that selling them provides substantial premium savings vis-à-vis the vanilla; and
  - as overlays on core cash positions for increasing leverage

**Reverse Knock-in Call/Put**:




Source: J.P. Morgan

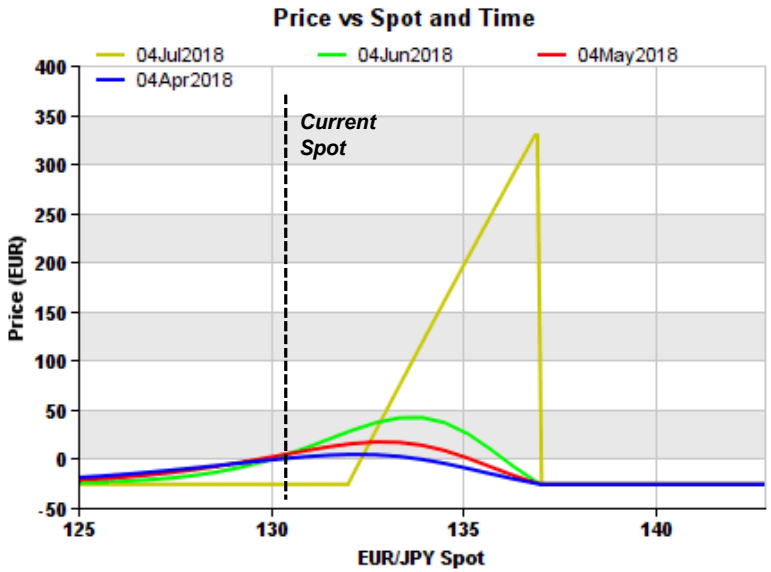
- **sold** to fund purchased options elsewhere
  - provides a margin of safety vs. selling vanilla outright
- A seller of a 116 strike USD/JPY call with 118 RKI is ***not*** short the 116 strike call till 118 trades, hence has 2 big figures of extra protection.
- RKI + RKO = Vanilla option identity holds

# Reverse knock-out example

**3M 132 strike EUR call / JPY put that knocks out at 137**

- Substantial cheapening of vanilla premium by setting a KO barrier
  - 26.07bp for RKO vs. 109.7bp for vanilla

- **Variation of price vs. spot:**
  - Early on, spot declines => reduce option premium similar to vanilla
  - RKO option price increases **initially** as spot drifts higher as the **vanilla call feature dominates**
  - Further on, **KO starts to dominate**
  - **RKOs can be considered to be:**
    - a combination of long a **vanilla** option and short ***one touch***




Source: J.P. Morgan

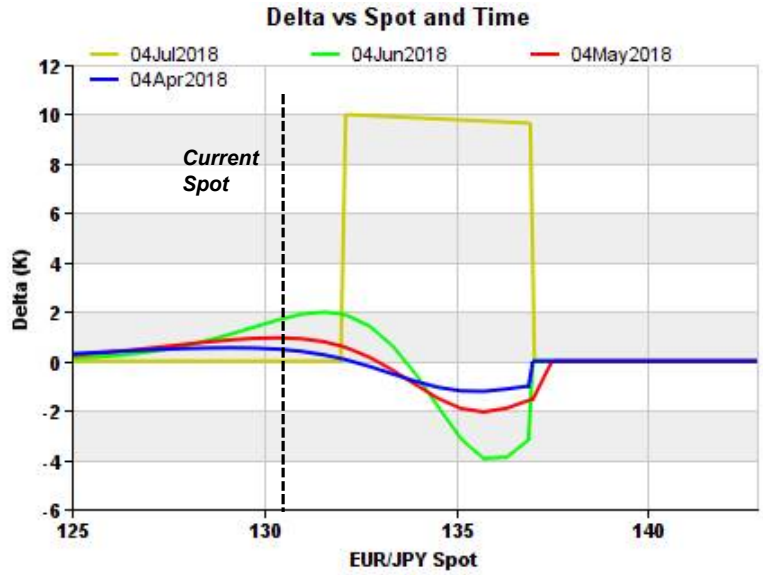
| | |
|---|---|
| **Name** | **Single Barrier With Rebate** |
| **Type** | Single Barrier With Rebate |
| **Market Date** | Wed 04Apr2018 |
| **Market State** | Mkt2 |
| **FX Pair** | EUR/JPY |
| **Option Type** | Call on EUR |
| **Expiration Date** | **Wed 04Jul2018 [91d]** |
| **Settlement Date** | Fri 06Jul2018 |
| **Strike** | **132.00** |
| **Settlement Type** | Physical |
| **Settlement Currency** | N/A |
| **Expiration Cut** | NYC |
| **Barrier** | **137.0000** |
| **Barrier Direction** | Up |
| **In or Out** | Out |
| **Rebate (% of Notional)** | 0.00 |
| **RebateCcy** | EUR |
| **Pay Time** | Expiry |
| | |
| **Quantity Currency** | EUR |
| **Quantity** | 10,000 |
| **Buy/Sell** | b - JPM Buys |
| | |
| **Spot** | **130.3262** |
| **Forward** | 130.3889 |
| **Forward Point** | 0.0627 |
| **Denominated Depo** | -0.21 |
| **Asset Depo** | -0.40 |
| **Vol for strike** | **8.186** |
| **ATM Volatility** | 8.346 |
| | |
| **Pricing Model** | Stoch Garf IR |
| **Premium Display** | % EUR |
| **Price(%)** | **0.2607** |
| **Vanilla(%)** | 1.097 |
| **BS Vanilla(%)** | 1.128 |
| **OneTouch(%)** | 21.60 |
| **BS OneTouch(%)** | 24.01 |
| **Premium Rebate(%)** | 0.3325 |

USER INPUTS

Source: J.P. Morgan

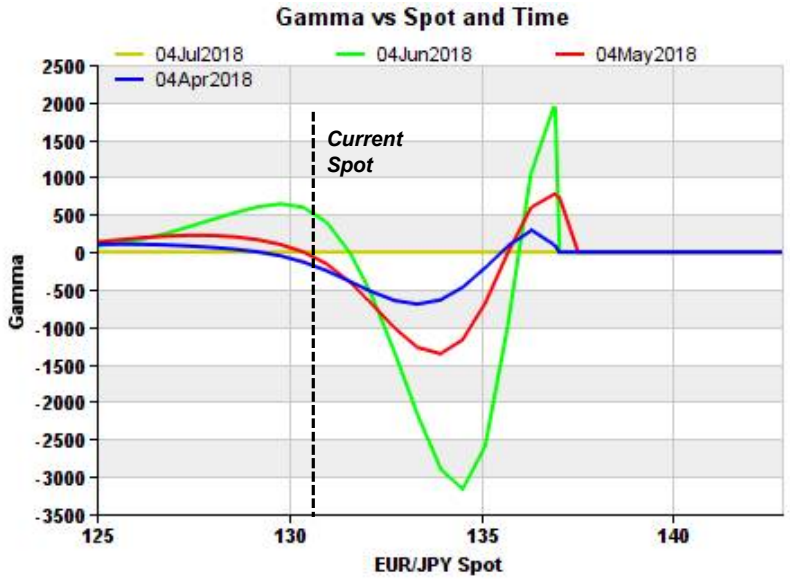
# Greeks of reverse knock-outs

- **Variation of Delta vs. spot and time**
  - Delta is initially positive (i.e. long EUR/JPY) ~ vanilla
  - As KO begins to dominate the positive effect of higher spot on the vanilla EUR call => ***delta flips to negative***
  - As barrier gets triggered => substantially negative ΔPrice, so ΔPrice / ΔSpot <<0
  - Delta is zero if the RKO barrier triggers
  - Passage of time reduces the probability of barrier breach => positive for price and delta




Source: J.P. Morgan

- **Variation of Gamma vs. spot and time**
  - Short gamma exposure => absence of spot movement is the most friendly outcome early on
  - Gamma becomes increasingly more negative as spot drifts higher
  - Gamma flips to peak positive just ahead of the RKO barrier, since small positive ΔSpot leads to a substantially positive Δdelta => ΔDelta / ΔSpot >>0
  - With time small spot moves have large influence on the likelihood of barrier survival => short gamma-ness increases




Source: J.P. Morgan





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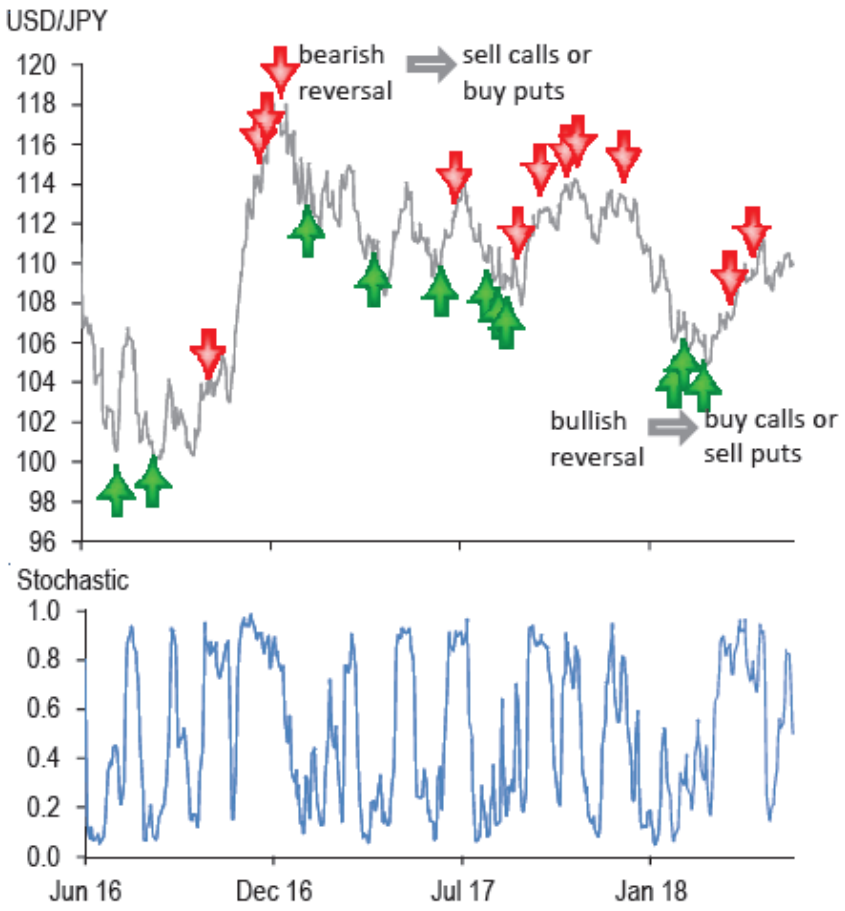
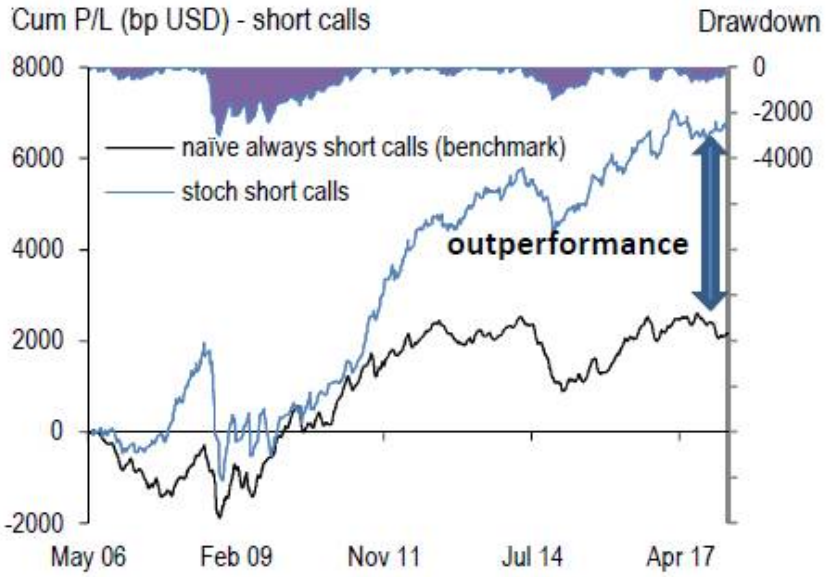
# Technical signals (stochastic oscillator) for directional options trading

**Stochastic oscillator bearish/bullish reversal points for USD/JPY**




Source: J.P. Morgan

**Timing of selling calls on bearish stochastic signal tripled the returns vs. a benchmark of equally weighted portfolio of 9 USD/G10 pairs**




Source: J.P. Morgan

**Stochastic oscillator generates alpha in FX options trading**

- stochastic indicator can spot signs of slowing or reversal in trend
  - potential leading indicator that can be used to time entry into directional FX options
- returns come from fading momentum of an existing trend
  - selling put options on "buy" signals and selling call options on "sell" signals favorable expressions that utilize stochastic oscillator

## GENERAL CONSIDERATIONS FOR DIRECTIONAL OPTION STRUCTURES

- **Is vol broadly rich or cheap?** Historical analysis on implied vol, implied vs. realized vol comparisons
- **For EM currencies in particular, is vol rich/cheap commensurate with the amount of carry?** Do not mind buying higher-than-average vol if interest rate carry is high and subsidizes a good portion of option theta
- **Is the trade in the direction of, or against the skew?** Options in the direction of the skew i.e. in the direction where vols are expensive e.g. USD calls/EM puts are ***nominally*** expensive to buy standalone but also provide the best *ex-post* returns. USD call/EM put spreads reduce nominal upfront premium vis-à-vis outright USD calls, but at the expense of performance if the directional view does indeed materialize. Think more deeply about the view.
- **Are risk-reversals rich or cheap?** Irrespective of the direction of the trade, this is an important input. If riskies are cheap, buy outright options in the direction of the skew; if expensive, spreads can be considered. Be biased to not buy outright options against the skew since vol will decline if spot moves in that direction; buy spreads unless skew is abnormally rich.
- The **trade-off between certain time decay versus uncertain payoff** demands close attention to rich/cheap analysis to avoid over-paying for options.

# Agenda



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### Implied Volatility

- forecast of how variable the underlying price is expected to be over the remaining life of the option.
- calculated from an option premium as the level of volatility that gives a theoretical option price equal to its market price

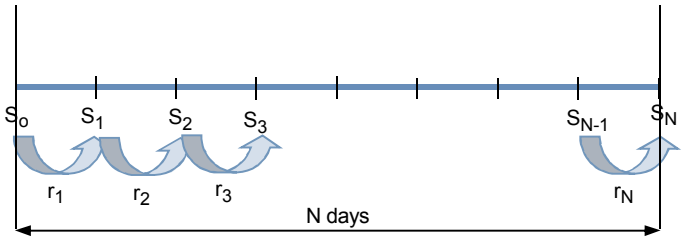
$$c = S_0 \exp(-r_f T)\mathbb{N}(d_1) - K \exp(-r_d T)\mathbb{N}(d_2)$$

$$d_1 = \frac{\ln(S_0/K) + (r_d - r_f + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

### Realized Volatility = calculated

$$\text{Non-mean adjusted or RMS volatility} = \sqrt{\frac{1}{N} * \sum_{i=1}^{N}\left[\ln\left(\frac{S_i}{S_{i-1}}\right)\right]^2} * \sqrt{252}$$




Source: J.P. Morgan

### Annualization of volatility

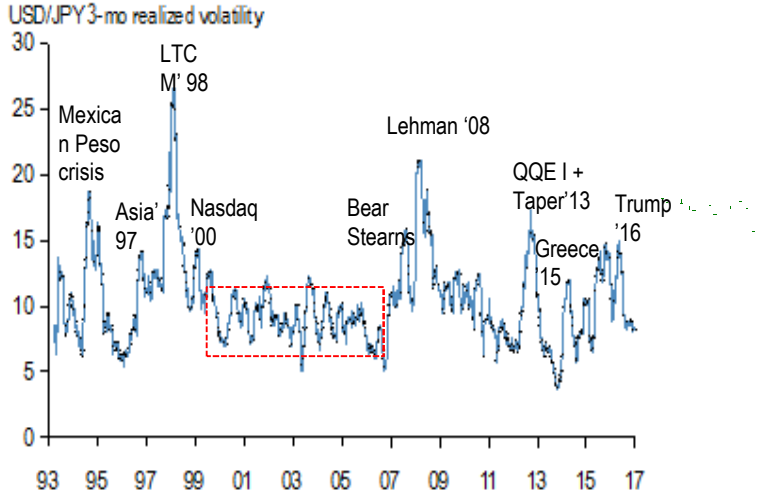
- The volatility of any sample of daily returns can be annualized by multiplying by √252
- The volatility of any sample of weekly returns can be annualized by multiplying by √52

### Additivity of variance

$$\sigma_N^2 = \frac{M * \sigma_M^2 + (N - M) * \sigma_{N\text{-}M}^2}{N}$$

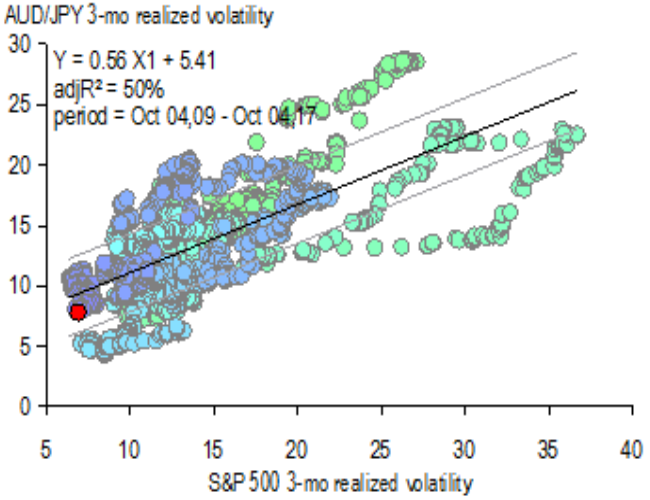
# HISTORICAL VOLATILITY IN FX

## Realized FX volatility tends to cluster into high and low regimes like every other asset class….



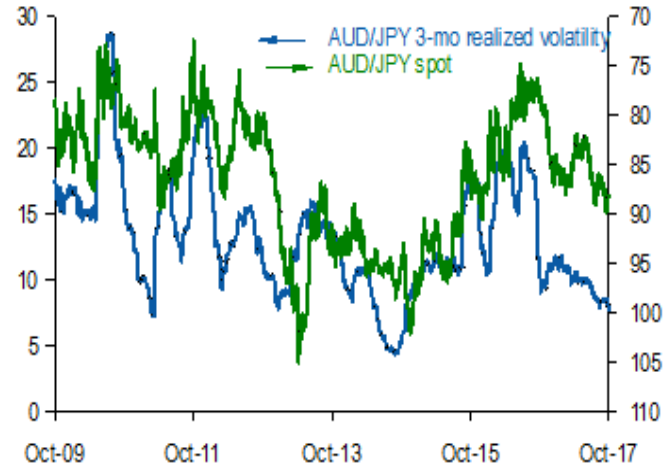

Source: J.P. Morgan

## …and is reasonably well correlated with equity volatility, especially in the high-beta / carry pairs



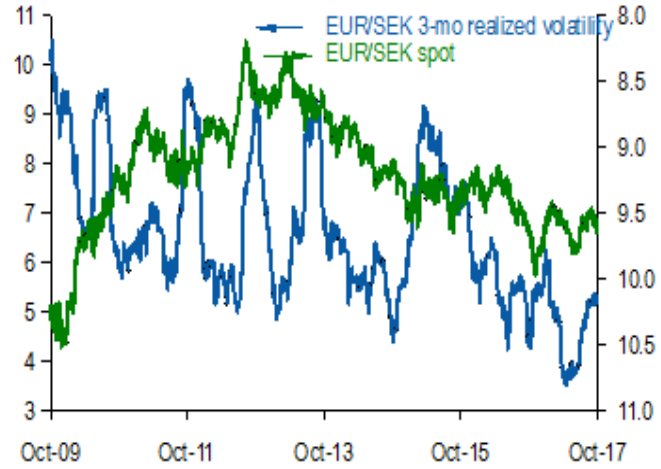

Source: J.P. Morgan

## Realized vol in some currency pairs like AUD/JPY are strongly correlated to spot moves




Source: J.P. Morgan

## …and not so much in some others like EUR/SEK




Source: J.P. Morgan



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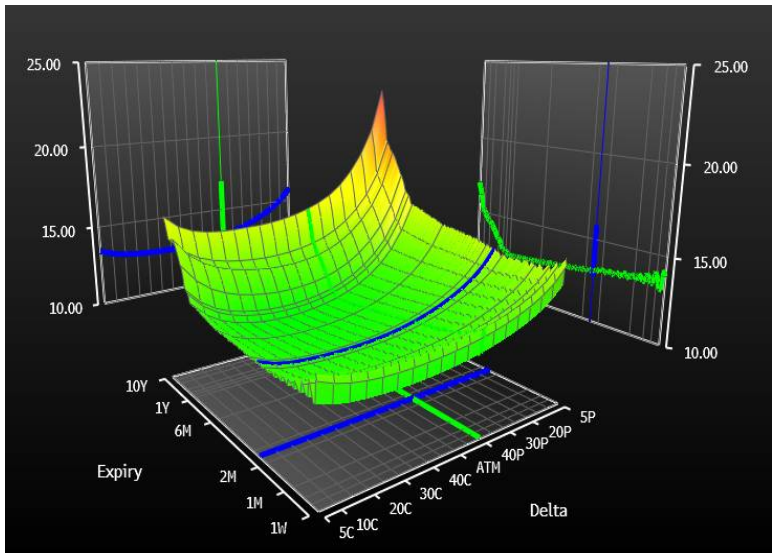
# IMPLIED VOLATILITY SURFACE

- Once the Black-Scholes assumption of constant volatility is relaxed, different values of volatilities can be quoted for different combinations of tenors and strikes.
- The market convention for implied vols is to quote five values for each tenor: **ATM vols,** and special measures of out-of-the-money vols : **Risk-Reversals and Butterflies for the 10D and 25D strikes.**
- Interpolation is needed to retrieve the vols for all deltas/strikes.

Quotation in Deltas is specific to FX and precious metals

**USD/JPY vol surface (source: Bloomberg)**




Source: Bloomberg

- Risk-reversal (RR) = Call vol – Put vol
- Butterfly (BF) = (Call vol + Put vol)/2 - ATM

- To retrieve vols for the individual calls and puts:

- Call vol = ATM + BF + (RR/2)
- Put vol = ATM + BF - (RR/2)

**ATMs, RRs, BFs ⇔ Absolute vol levels**

| | ATM | 25D RR | 25D BF | 10D RR | 10D BF |
|---|---|---|---|---|---|
| 1M | 13.2 | -0.9 | 0.3 | -1.7 | 0.9 |
| 2M | 13.1 | -1.0 | 0.4 | -1.9 | 1.0 |
| 3M | 12.9 | -1.1 | 0.4 | -2.1 | 1.3 |
| 6M | 12.5 | -1.2 | 0.5 | -2.3 | 1.6 |
| 1Y | 12.4 | -1.3 | 0.6 | -2.6 | 2.1 |
| 18M | 12.6 | -1.4 | 0.6 | -2.7 | 2.2 |
| 2Y | 12.8 | -1.5 | 0.6 | -2.8 | 2.2 |
| 3Y | 13.5 | -1.5 | 0.6 | -2.7 | 2.4 |
| 5Y | 14.6 | -1.6 | 0.6 | -3.0 | 2.4 |

| | 10D Put | 25D Put | ATM | 25D Call | 10D Call |
|---|---|---|---|---|---|
| 1M | 14.9 | 14.0 | 13.2 | 13.1 | 13.3 |
| 2M | 15.1 | 14.0 | 13.1 | 13.0 | 13.2 |
| 3M | 15.2 | 13.9 | 12.9 | 12.8 | 13.2 |
| 6M | 15.4 | 13.6 | 12.5 | 12.4 | 13.0 |
| 1Y | 15.9 | 13.7 | 12.4 | 12.4 | 13.3 |
| 18M | 16.3 | 14.0 | 12.6 | 12.6 | 13.6 |
| 2Y | 16.5 | 14.2 | 12.8 | 12.7 | 13.7 |
| 3Y | 17.3 | 14.9 | 13.5 | 13.5 | 14.6 |
| 5Y | 18.6 | 16.1 | 14.6 | 14.6 | 15.6 |

Source: J.P. Morgan

# IMPLIED VOLATILITY SURFACE QUOTING CONVENTIONS

## Definitions of At-the-Money (ATM)

- At-the-money-spot (ATMS): K = S (100% strike in equities)
- At-the-money-forward (ATMF): K = F (common in EM FX)
- **Delta-neutral (D/N):** K such that call delta = - put delta i.e. net delta of a straddle (long call + long put) is zero. Eliminates need for the market-maker to delta-hedge

## Variants of delta

- **Spot delta**: textbook delta = $\delta P/\delta S$ = spot sensitivity
- **Forward delta**: $\delta P/\delta F$ = forward sensitivity, used to capture interest rate risk implicit in forward points. Typically for NDF currencies and long-dated options
- **Black Scholes delta**: output from textbook B/S model
- **Smile delta**: B/S delta adjusted to account for variation of vol with strike
- **Premium adjusted delta**: Takes care of the correction induced by payment of the premium in foreign currency, which is the amount by which the delta-hedge in foreign currency has to be reduced.

  $\Delta_{PREMIUM\ ADJUSTED} = \Delta_{PREMIUM\ UNADJUSTED} - (p/S)$,

  p = premium in domestic ccy per unit of foreign ccy

## Market conventions of ATM and delta

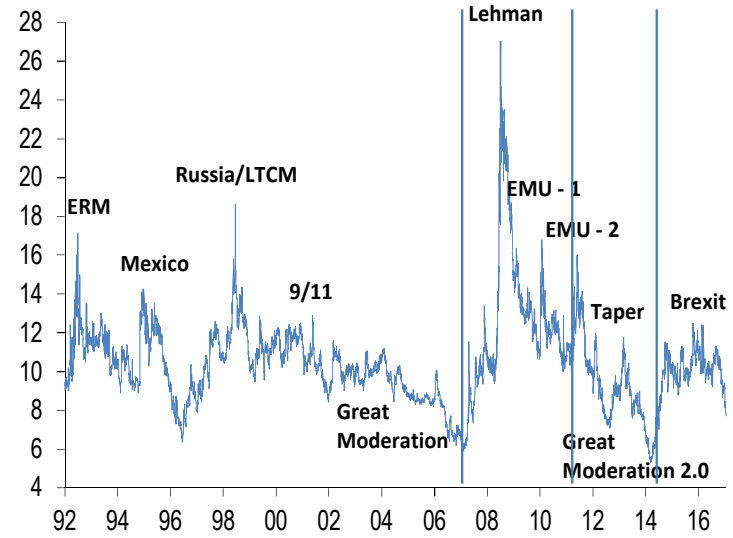
| Pair | Premium-adjusted delta? | Spot Delta ≤ 1Y? | ATM |
|---|---|---|---|
| EUR/USD | No | Yes | DNS |
| AUD/USD | No | Yes | DNS |
| GBP/USD | No | Yes | DNS |
| NZD/USD | No | Yes | DNS |
| USD/CAD | Yes | Yes | DNS |
| USD/CHF | Yes | Yes | DNS |
| USD/JPY | Yes | Yes | DNS |
| USD/NOK | Yes | Yes | DNS |
| USD/SEK | Yes | Yes | DNS |
| EUR/AUD | Yes | Yes | DNS |
| EUR/CAD | Yes | Yes | DNS |
| EUR/CHF | Yes | Yes | DNS |
| EUR/GBP | Yes | Yes | DNS |
| EUR/JPY | Yes | Yes | DNS |
| EUR/NOK | Yes | Yes | DNS |
| EUR/NZD | Yes | Yes | DNS |
| EUR/SEK | Yes | Yes | DNS |
| CAD/JPY | Yes | Yes | DNS |
| CHF/JPY | Yes | Yes | DNS |
| AUD/JPY | Yes | Yes | DNS |
| GBP/JPY | Yes | Yes | DNS |
| NZD/JPY | Yes | Yes | DNS |
| AUD/NZD | Yes | Yes | DNS |
| AUD/CAD | Yes | Yes | DNS |
| AUD/CHF | Yes | Yes | DNS |
| GBP/AUD | Yes | Yes | DNS |
| GBP/CAD | Yes | Yes | DNS |
| GBP/CHF | Yes | Yes | DNS |

| Pair | Premium-adjusted delta? | Spot Delta ≤ 1Y? | ATM |
|---|---|---|---|
| USD/BRL | Yes | No | ATMF |
| USD/CLP | Yes | No | ATMF |
| USD/ILS | Yes | No | DNS |
| USD/MXN | Yes | No | ATMF |
| USD/TRY | Yes | No | DNS |
| USD/ZAR | Yes | No | DNS |
| EUR/BRL | Yes | No | ATMF |
| EUR/CLP | Yes | No | ATMF |
| EUR/ILS | Yes | No | DNS |
| EUR/MXN | Yes | No | ATMF |
| EUR/TRY | Yes | No | DNS |
| EUR/ZAR | Yes | No | DNS |
| BRL/JPY | Yes | No | ATMF |
| MXN/JPY | Yes | No | ATMF |
| TRY/JPY | Yes | No | DNS |
| ZAR/JPY | Yes | No | DNS |
| BRL/CLP | Yes | No | ATMF |
| BRL/MXN | Yes | No | ATMF |
| CAD/BRL | Yes | No | ATMF |
| CAD/MXN | Yes | No | ATMF |
| CHF/MXN | Yes | No | ATMF |
| ZAR/TRY | Yes | No | DNS |

Source: J.P. Morgan

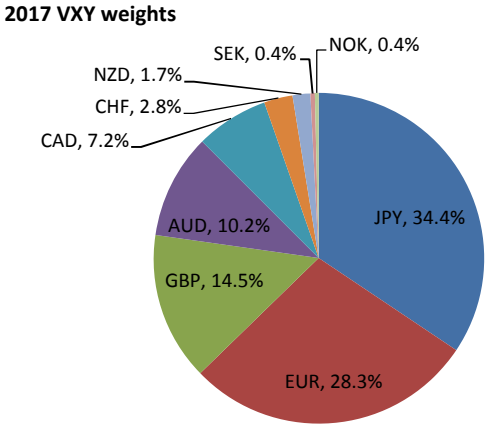
# VXY: JPM FX IMPLIED VOLATILITY INDICES

- Industry benchmark for tracking aggregate volatility in currencies analogous the CBOE Volatility Index® (VIX®) used in Equity markets.
- VXY is an index of **3M ATM vols** across USD-pairs, with weights based on the BIS Triennial Central Bank Survey of turnover in FX markets.
- Bloomberg tickers: JPMVXYG7, JPMVXYEM, JPMVXYGL



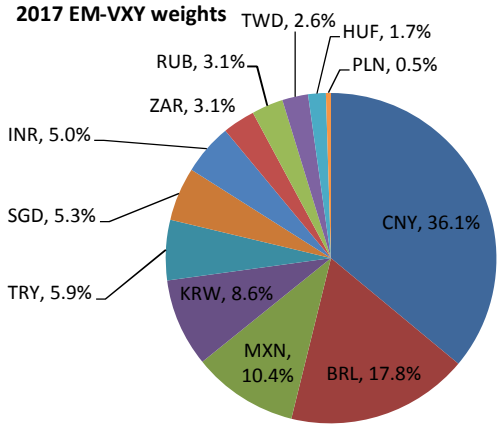

Source: J.P. Morgan

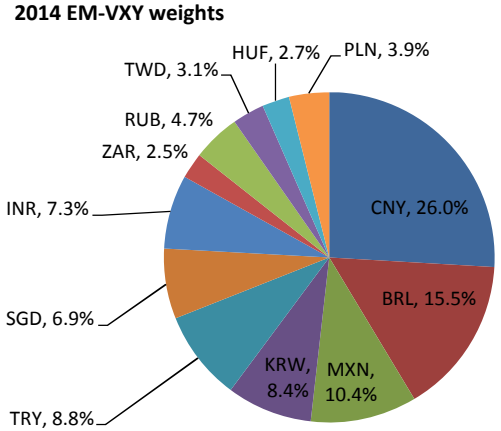
## Composition of VXY G7




Source: J.P. Morgan

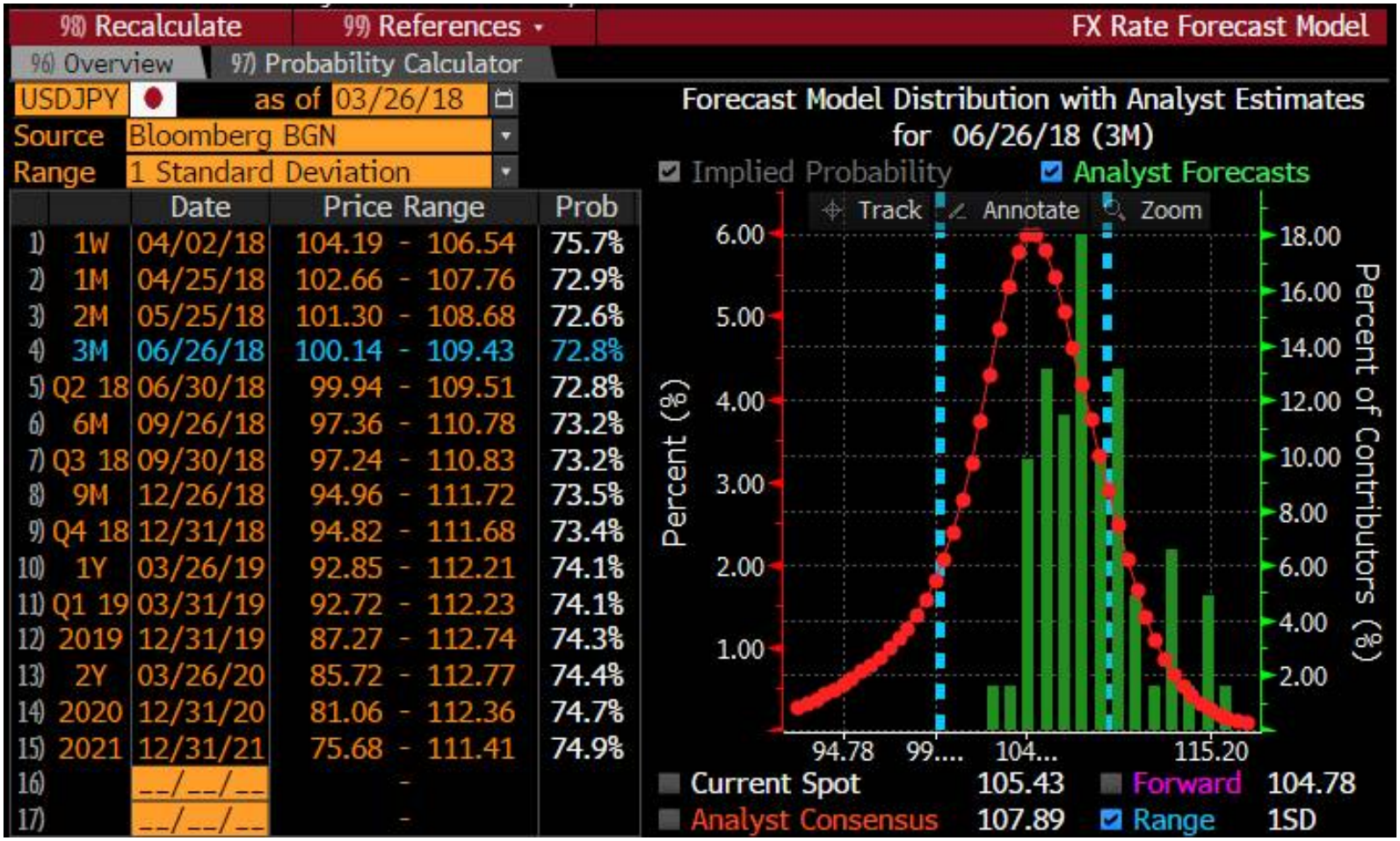
## Composition of VXY EM




Source: J.P. Morgan

## OPTION IMPLIED DISTRIBUTIONS ON BLOOMBERG

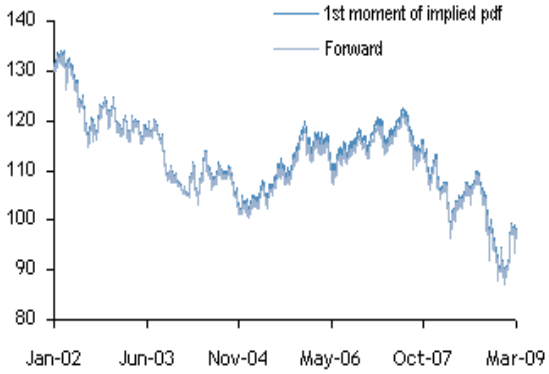



Source: Bloomberg

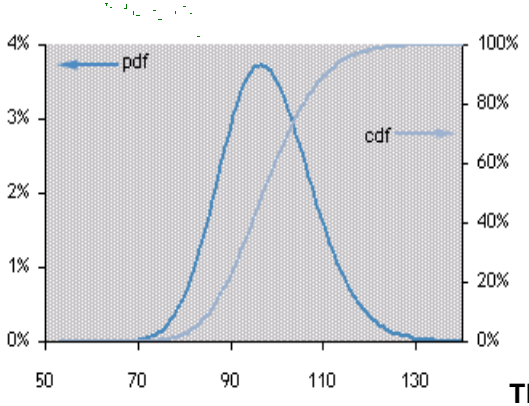
# MOMENTS OF OPTION IMPLIED DISTRIBUTIONS

**The first moment of the implied distribution is the forward**

There is no incremental information that is to be gleaned from the option market as regards $M_1$



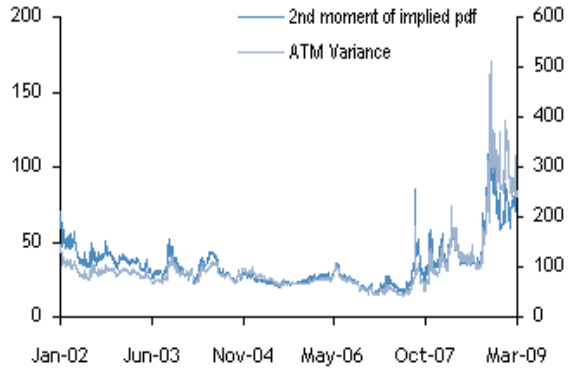

Source: J.P. Morgan




Source: J.P. Morgan

**The second moment of the implied distribution is a function* of the ATM variance**

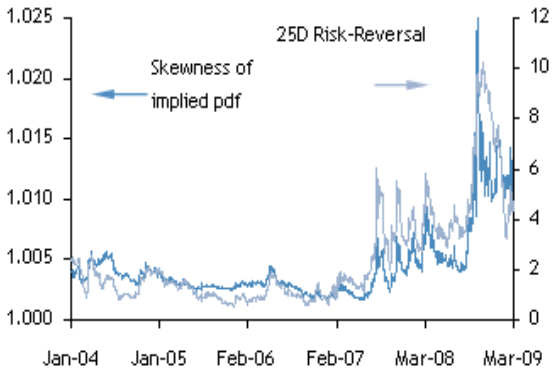
For $M_2$ therefore, just the ATM vol is enough of a proxy, the rest of the vol surface is immaterial




* $\sigma_{ATM}^2 = \ln (M_2/M_1^2)$

Source: J.P. Morgan

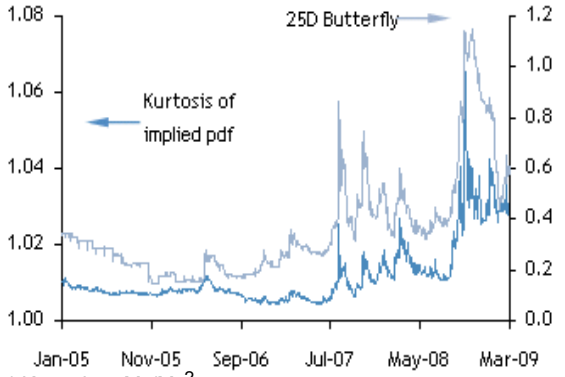
**The skewness* of the implied distribution is highly correlated to risk-reversals (call vol – put vol)**




* Skewness = $M_3/M_2^{3/2}$

Source: J.P. Morgan

**The kurtosis* of the implied distribution is highly correlated to butterflies**

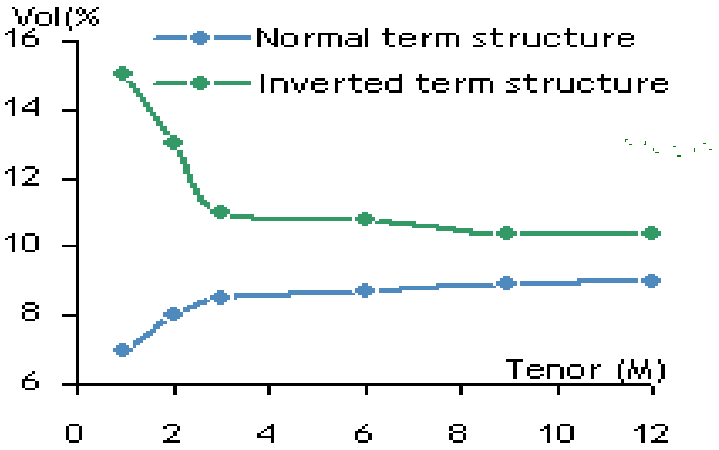



* Kurtosis = $M_4/M_2^2$

Source: J.P. Morgan

# DECOMPOSING THE VOL SURFACE: TERM STRUCTURE (VOL CURVE)

- View on gamma is essential to formulating a curve view.

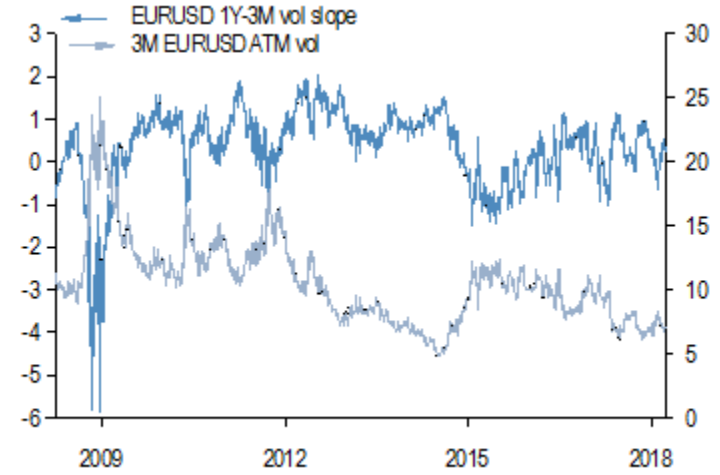



Source: J.P. Morgan

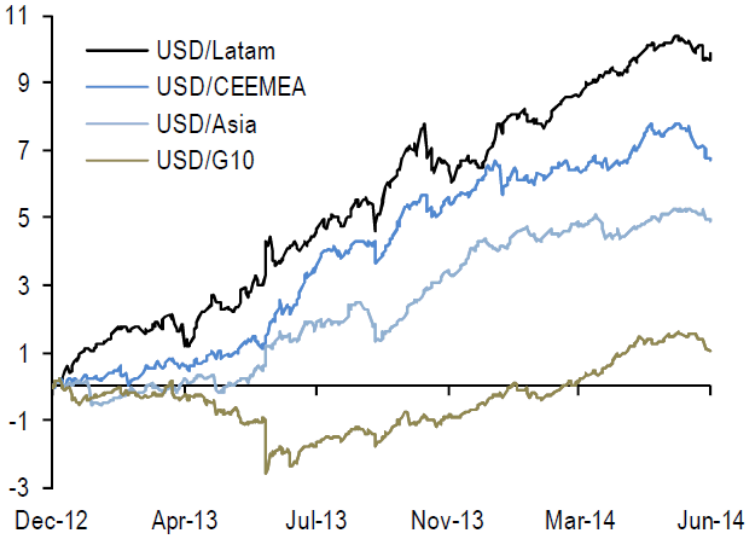
**Vol curve steepeners have been a sturdy source of alpha in EM FX, less so in G10**

- Cumulative returns (in vol pts.) from vega-neutral **short 3M vs. long 1Y straddle** spreads
- Options delta-hedged daily using smile forward deltas and option maturity-matched forwards/NDFs, and rolled into fresh strikes every 3-months

- **Vol curves mean-reverting, more than the vols**
  - Vol curve trades: buying/selling ***vega-neutral*** amounts




Source: J.P. Morgan




Source: J.P. Morgan



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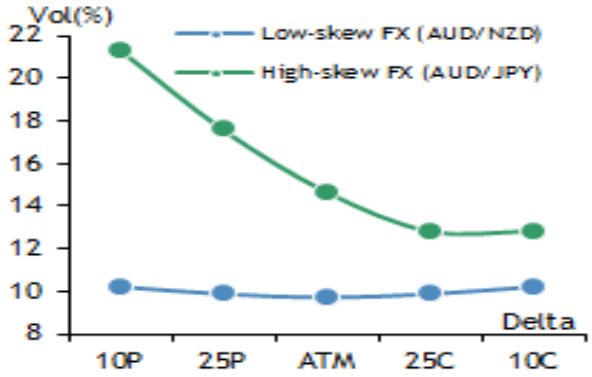
## DECOMPOSING THE VOL SURFACE: RISK REVERSAL (VOL SKEW)

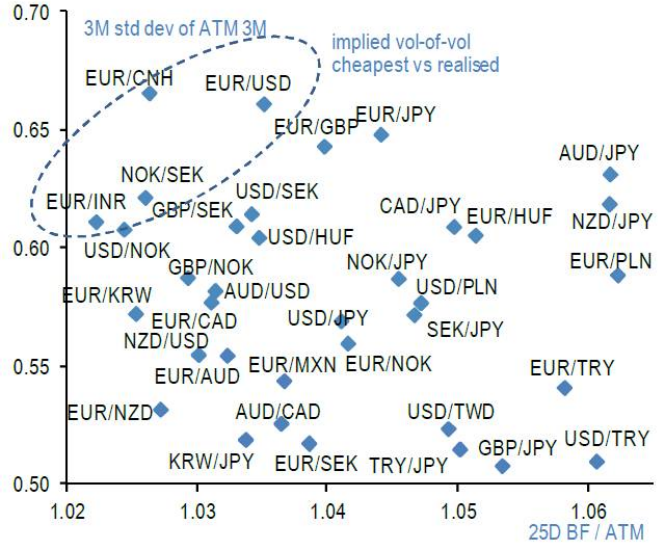
- Risk-reversals reflect the option market's expectation of a change in ATM implied vols for a given move in spot
- Well correlated to the **correlation between spot and vol moves**
- Often valued by comparing them to ATM vol (RR / ATM ratio)
- The highest carry attract the most flows => susceptible to the sharpest unwinds
  - skews bid higher for carry currency puts




Source: J.P. Morgan

## DECOMPOSING THE VOL SURFACE: BUTTERFLY (VOL FLY)

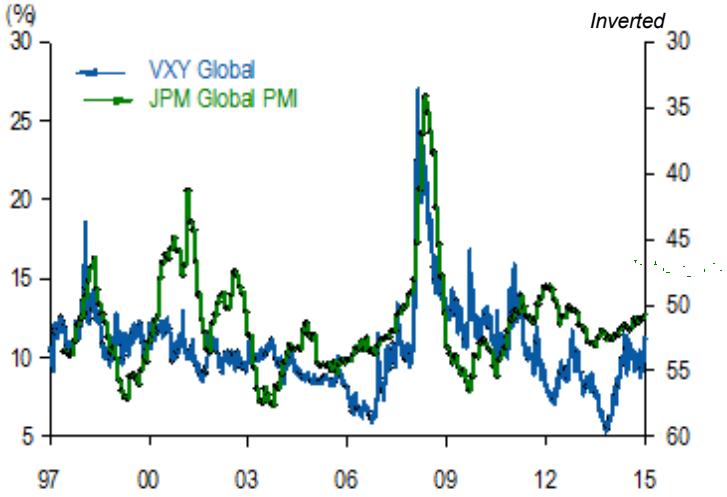
- Convexity of the vol surface
- Quoted as the *mean* of the volatilities of fixed delta call and put strikes (10-delta and 25-delta are standard) minus ATM vol
- flies (a non-directional measure of the variation of vol with strike) - well-correlated with volatility (or stdev) of ATM vol => captures **vol-of-vol**




Source: J.P. Morgan

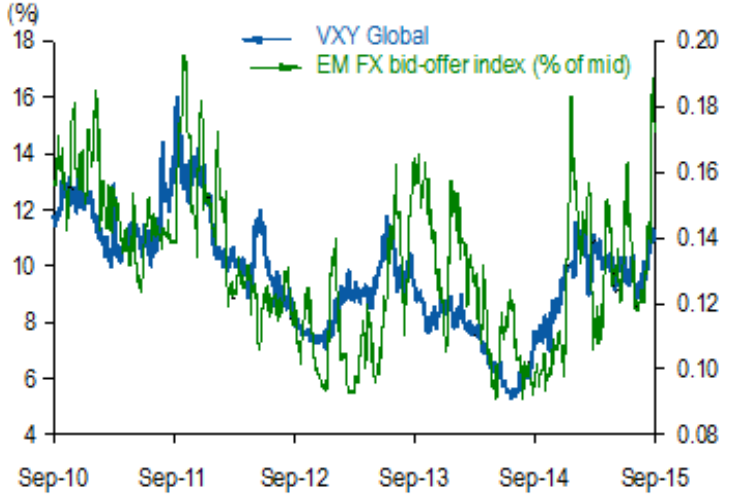
# SOME GENERAL VOLATILITY CONCEPTS

## Volatility responds to macro developments



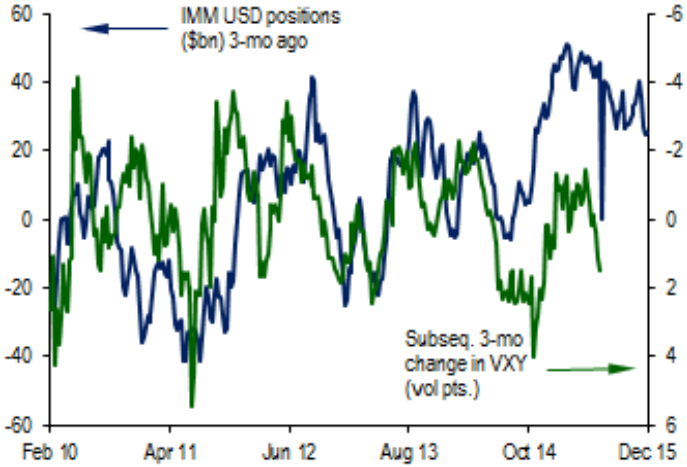

Source: J.P. Morgan

## Market micro-structure matters too



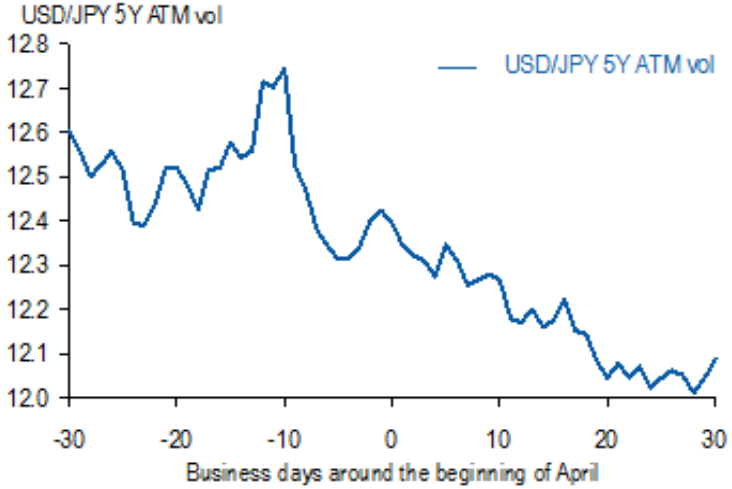

Source: J.P. Morgan

## Cash pre-positioning is key to future vol movements




Source: J.P. Morgan

## Demand and supply of options heavily influences option prices, especially in longer tenors




Source: J.P. Morgan





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# Agenda



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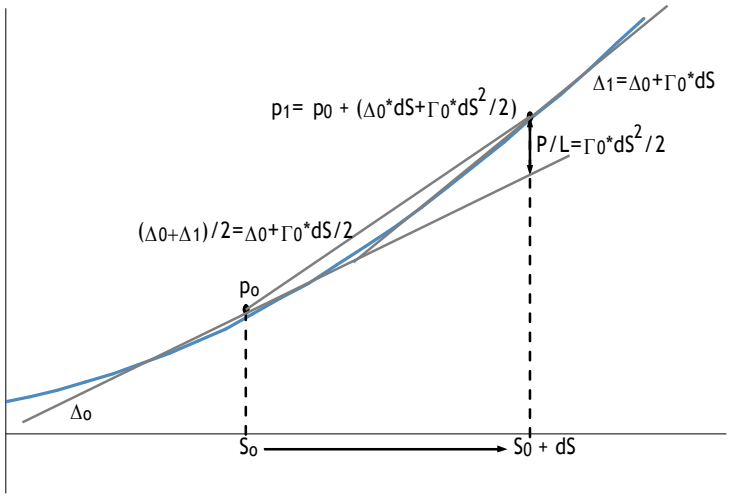
- What if you have a view on volatility, but no view on spot?
- Volatility Trading is profiting from a discrepancy between implied volatility and realized volatility or in changes in implied volatility
- In Vanilla Options the two primary ways to profit from volatility trading:
  - Gamma Trading
  - Vega Trading
- In Exotic Options, there are various structures that can be used to express a volatility view. The most basic:
  - Forward Volatility Agreements
  - Volatility Swaps
  - Variance Swaps

**Gamma P/L from delta hedging an option**

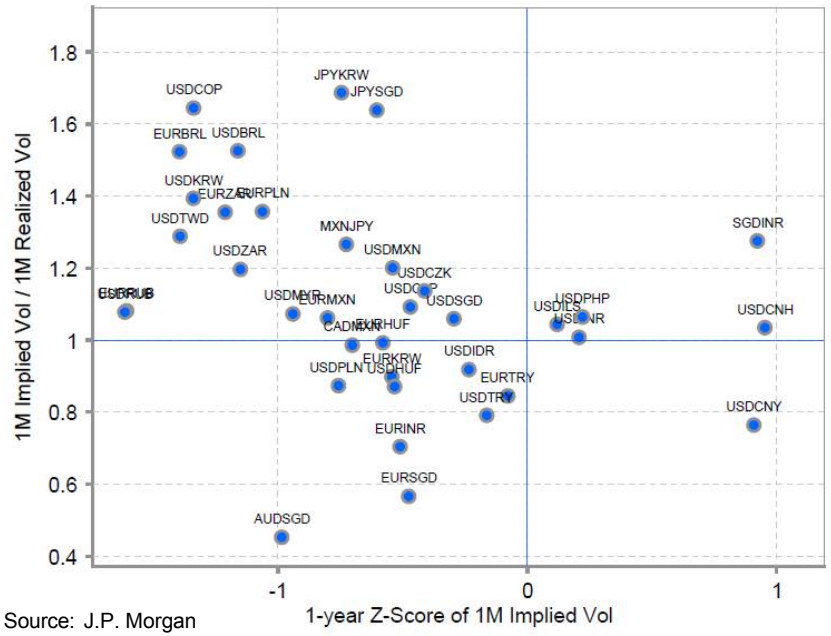



Source: J.P. Morgan

# TRACKING VOLATILITY VALUATIONS

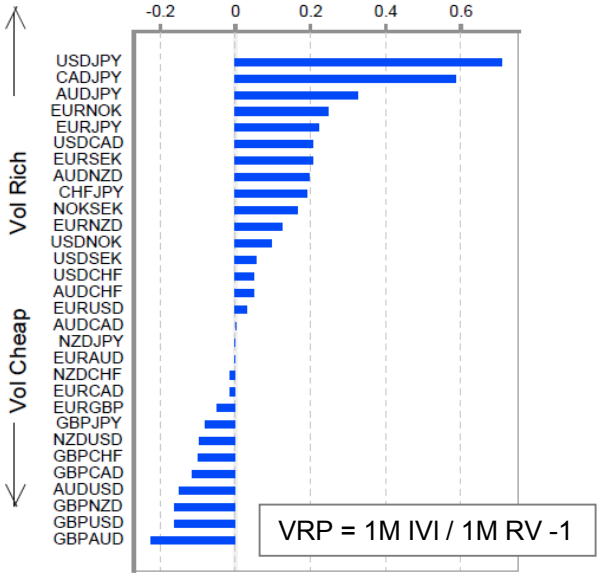
- Implied / realized volatility ratios are a commonly accepted and widely used approach to tracking richness/cheapness of front-end vols
- Plotting implied/realized ratios along with implied vol z-scores on the same chart provides a better perspective on the trade-off between the richness / cheapness of implied vols relative to history and to realized vols
- The theme at the front-end of G10 vols seems to be that gamma in JPY is elevated amid upcoming elections and GBP x-vols performing as weekly dose of Brexit uncertainty keeps spot jittery.
- EM: depressed implied vols but even softer realized vols => notable option premium in such as BRL

**EM gamma (1M vol) metrics**



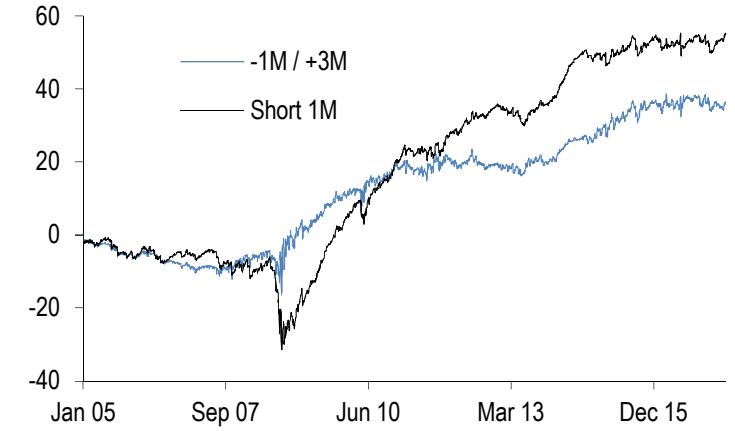

Source: J.P. Morgan

**G10 currency pairs ranked in order of 1M Normalized VRP***




Source: J.P. Morgan

**Cum P/L (vol pts) for Short 1M (VXY-GL weights)**




Source: J.P. Morgan

TRADING VOLATILITY AS AN ASSET CLASS



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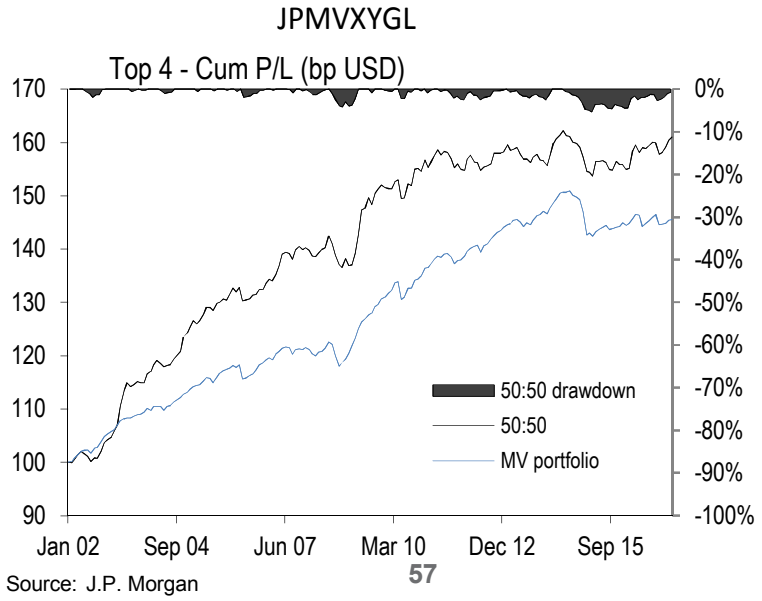
# Short vol shows undesirable left tail – carry a worthy complement

**Short straddles: good returns but downside risk**
**ATMF options best compromise**

| carry/premium | | Short straddle ATMF carry EW | Short straddle ATMF carry Top 4 | ATMF carry EW | ATMF carry Top 4 | ATMF/ATMS carry EW | ATMF/ATMS carry Top 4 | Short straddle ATMF carry EW | Short straddle ATMF carry Top 4 | ATMF carry EW | ATMF carry Top 4 | ATMF/ATMS carry EW | ATMF/ATMS carry Top 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-50 | | | | | | 50-100 | | | | | |
| 50-100 | ret | 1.4% | 3.2% | **1.9%** | **6.4%** | 0.5% | **2.5%** | **-1.7%** | **-1.7%** | 0.8% | 2.6% | -0.2% | 1.1% |
| | stdev | 0.9% | 1.3% | 2.4% | 4.5% | 0.5% | 1.6% | 1.3% | 3.0% | 3.1% | 5.2% | 0.6% | 1.9% |
| | SR | **1.62** | **2.34** | 0.78 | **1.41** | 0.97 | **1.54** | -1.31 | -0.57 | 0.25 | 0.50 | -0.24 | 0.56 |
| | skew | -0.89 | -0.80 | 1.72 | 1.62 | 1.42 | 1.75 | -0.77 | **-1.93** | 0.24 | 1.55 | -0.04 | 0.58 |
| | kurtosis | 1.33 | 1.63 | 6.09 | 5.70 | 5.67 | 5.87 | 0.34 | 5.32 | -0.48 | 3.66 | -0.66 | -0.39 |
| 0-50 | ret | 2.6% | **3.5%** | -0.6% | 1.7% | 0.1% | 1.0% | 1.6% | 3.1% | 1.1% | 3.6% | 0.0% | 0.5% |
| | stdev | 1.0% | 1.9% | 2.3% | 3.9% | 0.4% | 1.2% | 2.0% | 2.5% | 4.6% | 6.3% | 0.6% | 1.5% |
| | SR | **2.63** | **1.82** | -0.28 | 0.43 | 0.15 | 0.77 | 0.78 | 1.21 | 0.23 | 0.57 | -0.04 | 0.30 |
| | skew | **-2.77** | **-3.71** | 0.27 | 0.58 | -0.26 | 0.39 | **-1.66** | **-1.79** | 0.65 | 0.85 | -0.24 | -0.14 |
| | kurtosis | 11.66 | 16.98 | -0.71 | -0.29 | -0.66 | -0.10 | 4.06 | 4.26 | 1.28 | 0.76 | 0.65 | 0.47 |

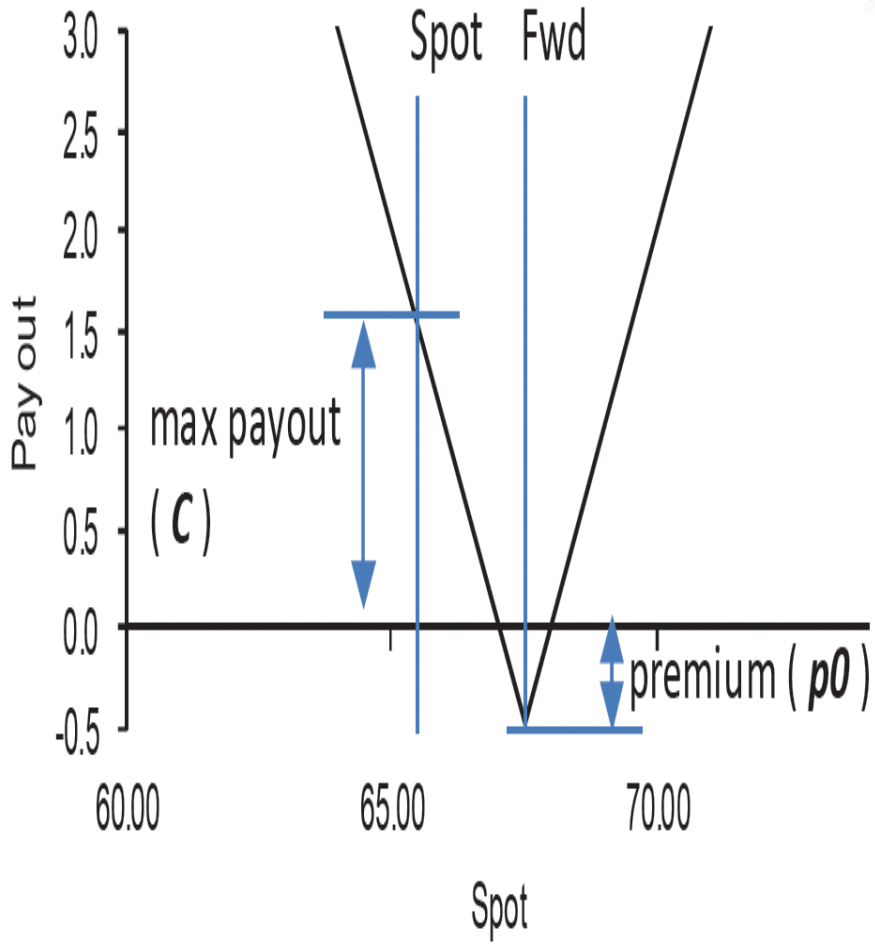
Source: J.P. Morgan




Source: J.P. Morgan

## CARRY / VOL IS AN INPUT INTO NON-DIRECTIONAL / VOL TRADES, ESPECIALLY IN EM CURRENCIES

### Chart 1. Stylized payout profile of a vanilla ATMF straddle in a high-yielding USD/EM currency pair

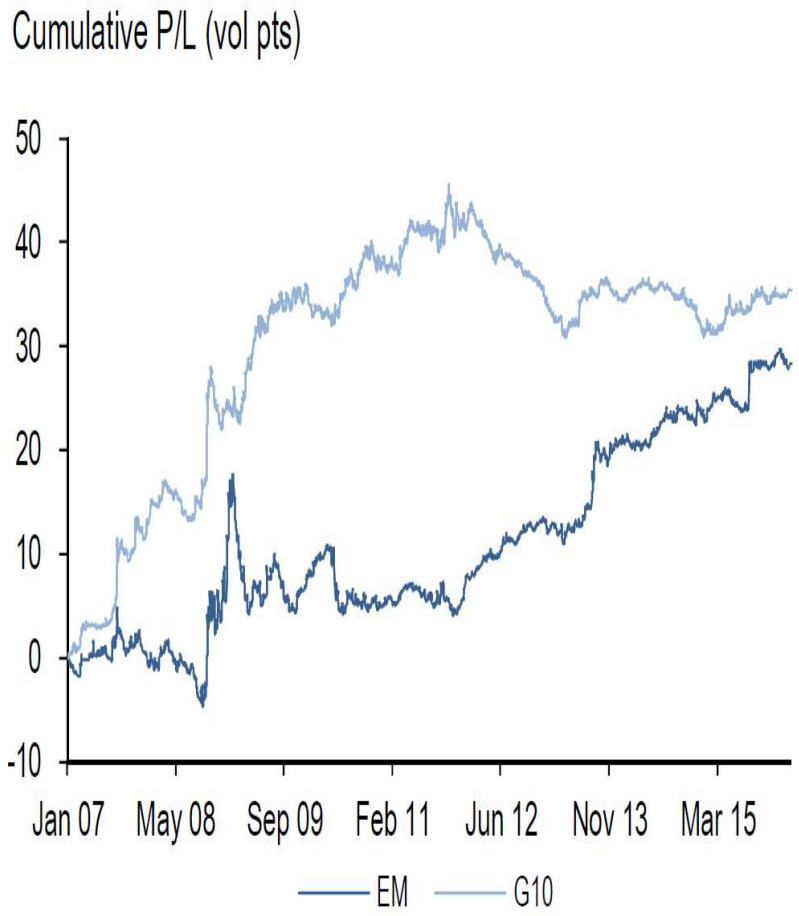



Source: J.P. Morgan

Source: *Extracting vol alpha using carry-to-risk signals*

### Chart 4. Cumulative P/Ls from buying top N carry/risk 6M tenor straddles and selling N lowest carry/risk straddles.

N = 3; 6M tenor options and no TC.

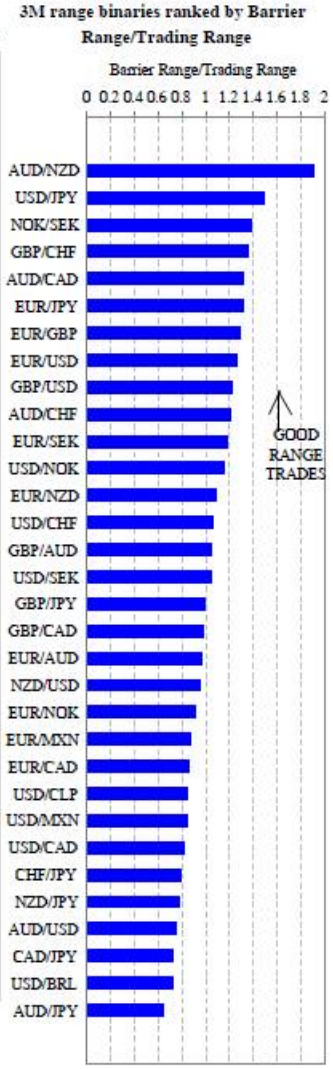


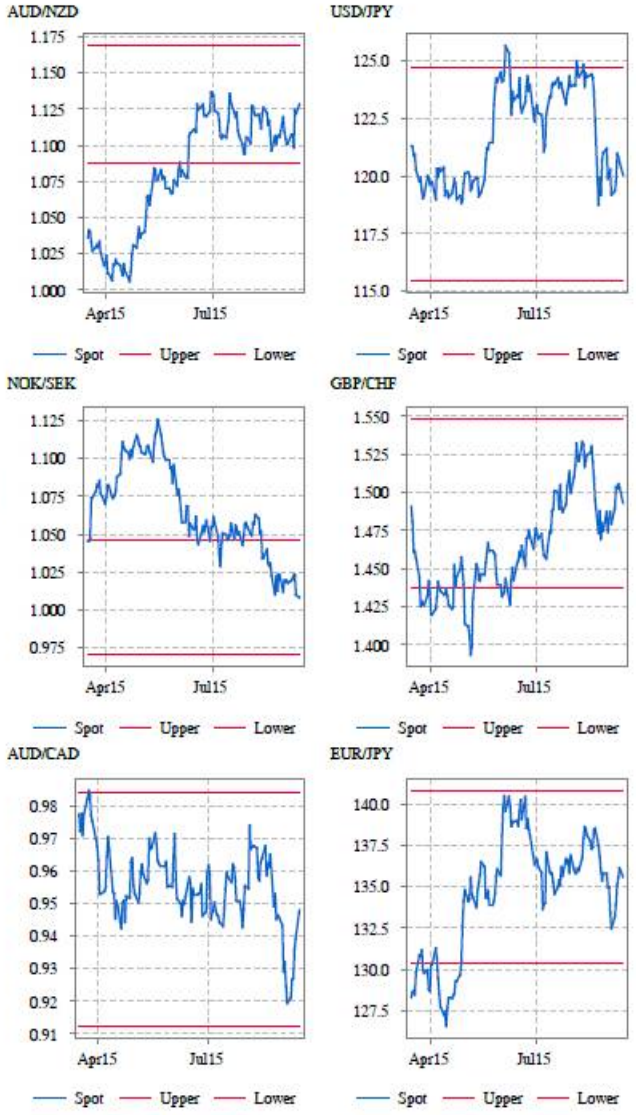

Source: J.P. Morgan

# DOUBLE NO-TOUCHES / RANGE BINARIES AS SHORT VOL PLAYS

## 3M Range Binary Report

| Ccy Pair | Spot | Tenor | Lower Barrier | Upper Barrier | 3M Spot Low | 3M Spot High | Binary Range / Trading Range |
|---|---|---|---|---|---|---|---|
| AUD/NZD | 1.1283 | 3M | 1.0877 | 1.1686 | 1.0941 | 1.1365 | 1.91 |
| USD/JPY | 120.07 | 3M | 115.4202 | 124.7098 | 118.7400 | 124.9950 | 1.49 |
| NOK/SEK | 1.0081 | 3M | 0.9702 | 1.0460 | 1.0081 | 1.0628 | 1.39 |
| GBP/CHF | 1.4932 | 3M | 1.4370 | 1.5479 | 1.4516 | 1.5331 | 1.36 |
| AUD/CAD | 0.9479 | 3M | 0.9124 | 0.9840 | 0.9195 | 0.9739 | 1.32 |
| EUR/JPY | 135.59 | 3M | 130.3818 | 140.7970 | 132.4801 | 140.4220 | 1.31 |
| EUR/GBP | 0.7338 | 3M | 0.7071 | 0.7606 | 0.6942 | 0.7356 | 1.29 |
| EUR/USD | 1.1293 | 3M | 1.0839 | 1.1747 | 1.0854 | 1.1576 | 1.26 |
| GBP/USD | 1.5390 | 3M | 1.4956 | 1.5823 | 1.5171 | 1.5884 | 1.22 |
| AUD/CHF | 0.6936 | 3M | 0.6587 | 0.7277 | 0.6722 | 0.7291 | 1.21 |
| EUR/SEK | 9.3468 | 3M | 9.0948 | 9.5988 | 9.2140 | 9.6415 | 1.18 |
| USD/NOK | 8.2101 | 3M | 7.8261 | 8.5940 | 7.7168 | 8.3854 | 1.15 |
| EUR/NZD | 1.7824 | 3M | 1.6881 | 1.8766 | 1.6202 | 1.7936 | 1.09 |
| USD/CHF | 0.9703 | 3M | 0.9336 | 1.0060 | 0.9177 | 0.9862 | 1.06 |
| GBP/AUD | 2.1527 | 3M | 2.0613 | 2.2447 | 2.0291 | 2.2037 | 1.05 |
| USD/SEK | 8.2767 | 3M | 7.9270 | 8.6263 | 8.1136 | 8.7860 | 1.04 |
| GBP/JPY | 184.77 | 3M | 177.5042 | 192.0439 | 180.8156 | 195.4500 | 0.99 |
| GBP/CAD | 2.0405 | 3M | 1.9695 | 2.1134 | 1.9367 | 2.0845 | 0.97 |
| EUR/AUD | 1.5797 | 3M | 1.5002 | 1.6595 | 1.4459 | 1.6109 | 0.97 |
| NZD/USD | 0.6336 | 3M | 0.6015 | 0.6657 | 0.6256 | 0.6935 | 0.94 |
| EUR/NOK | 9.2716 | 3M | 8.9204 | 9.6228 | 8.7356 | 9.5096 | 0.91 |
| EUR/MXN | 18.98 | 3M | 17.8152 | 20.0593 | 17.2205 | 19.8056 | 0.87 |
| EUR/CHF | 1.0957 | 3M | 1.0671 | 1.1233 | 1.0362 | 1.1013 | 0.86 |
| EUR/CAD | 1.4973 | 3M | 1.4349 | 1.5612 | 1.3792 | 1.5270 | 0.85 |
| USD/CLP | 687.65 | 3M | 656.2909 | 719.7091 | 630.0350 | 705.1300 | 0.84 |
| USD/MXN | 16.81 | 3M | 15.9831 | 17.5545 | 15.2465 | 17.1099 | 0.84 |
| USD/CAD | 1.3259 | 3M | 1.2810 | 1.3720 | 1.2196 | 1.3306 | 0.82 |
| CHF/JPY | 123.75 | 3M | 119.0256 | 128.5822 | 122.2160 | 134.2650 | 0.79 |
| NZD/JPY | 76.07 | 3M | 71.8941 | 80.2523 | 74.6563 | 85.4485 | 0.77 |
| AUD/USD | 0.7149 | 3M | 0.6814 | 0.7482 | 0.6927 | 0.7826 | 0.74 |
| CAD/JPY | 90.55 | 3M | 86.4206 | 94.6040 | 89.5918 | 100.8363 | 0.73 |
| USD/BRL | 3.8666 | 3M | 3.5279 | 4.1321 | 3.0576 | 3.8890 | 0.73 |
| AUD/JPY | 85.83 | 3M | 81.4590 | 90.1859 | 82.6667 | 96.2419 | 0.64 |




Note:
1. All range binaries are selected such that their barriers are equidistant from spot on either side, and cost 20% TV (w/o bid-offer) i.e. a 5:1 payout ratio. Range binaries with high barrier range/trading range ratio have barriers that subsume a large fraction of the recent historical trading range of spot, and should therefore count as better range binary candidates than the rest.
2. Note that the range barriers are agnostic i.e. they assume no view on spot, nor do they take into account any historical trend in spot till today. A dealable range binary trade may therefore need a tweak of the barriers higher or lower depending on the investor's view on spot.

Source: J.P. Morgan



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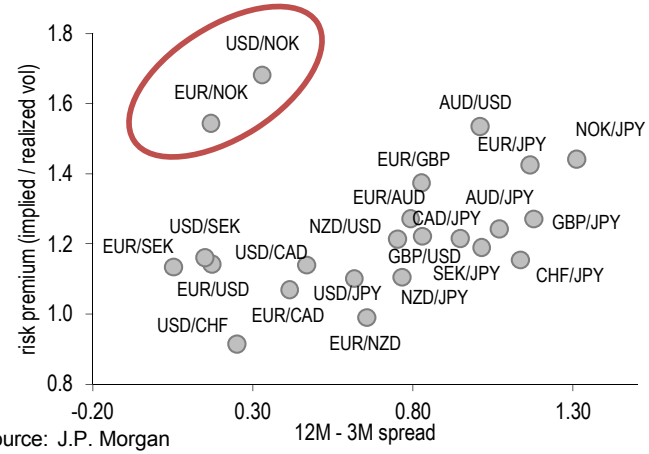
# Curve trades | Gamma spreads

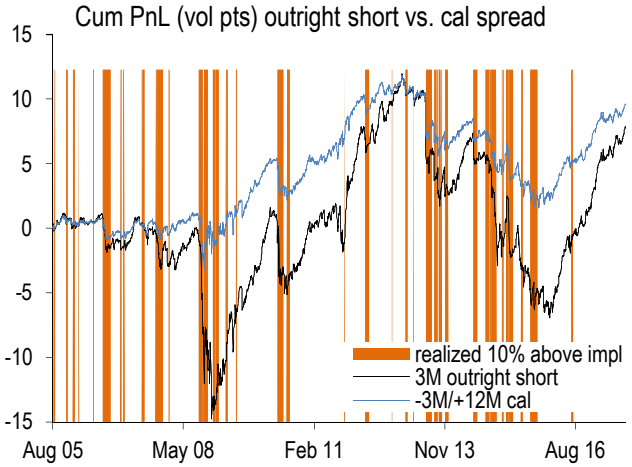
## NOK -3M/+9M calendar

**NOK screens favorably within G10 for short gamma plays given the richness of NOK front vols vis-à-vis realized vols**
Left upper corner (high risk premium and flat or inverted vol curves) currencies are best placed for short front vs. long back cal spread trades.



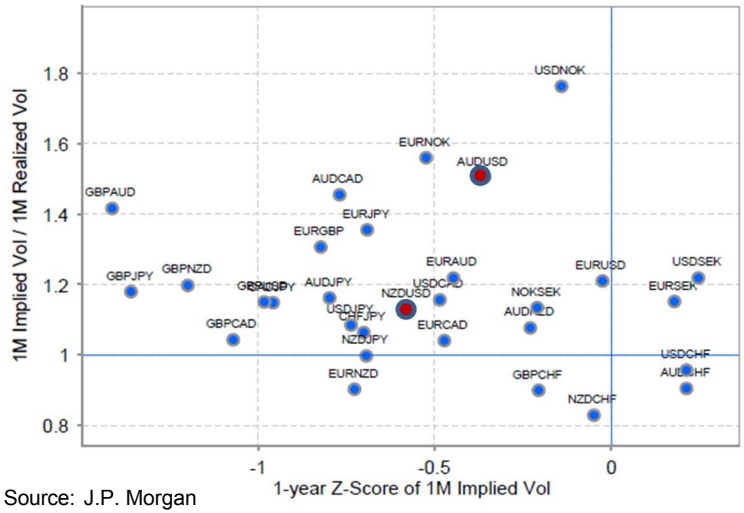

Source: J.P. Morgan

**EUR/NOK calendars show appealingly strong recent upside trend.**
Cumulative P/L (vol pts) (LHS) EUR/NOK short 3M / Long 12M delta-hedged calendar spread vs. outright 3M short vol



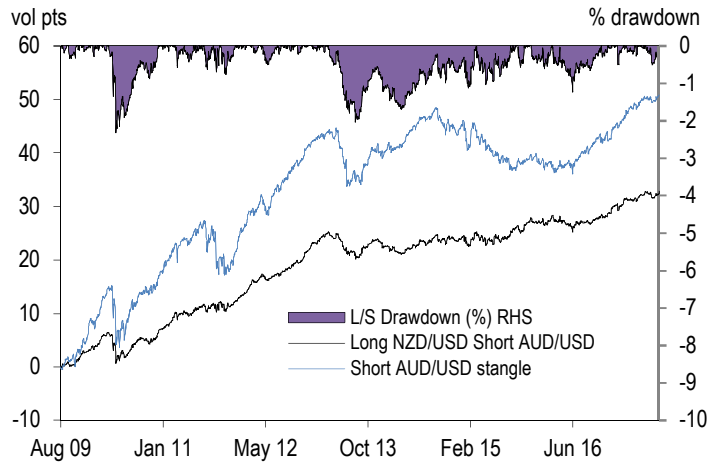

Source: J.P. Morgan

## NZD/USD – AUD/USD gamma spread




Source: J.P. Morgan

**NZD/USD-AUD/USD vol spread has shown a solid historical track record and have clearly outpaced standalone AUD/USD delta-hedged short straddles in terms of risk adjusted returns and drawdowns.**
Cumulative P/L (vol pts) and drawdowns for long/short delta-hedged vol RV between 3M NZD/USD straddles and AUD/USD 25 delta strangles, in100:150 vega notionals.




Source: J.P. Morgan



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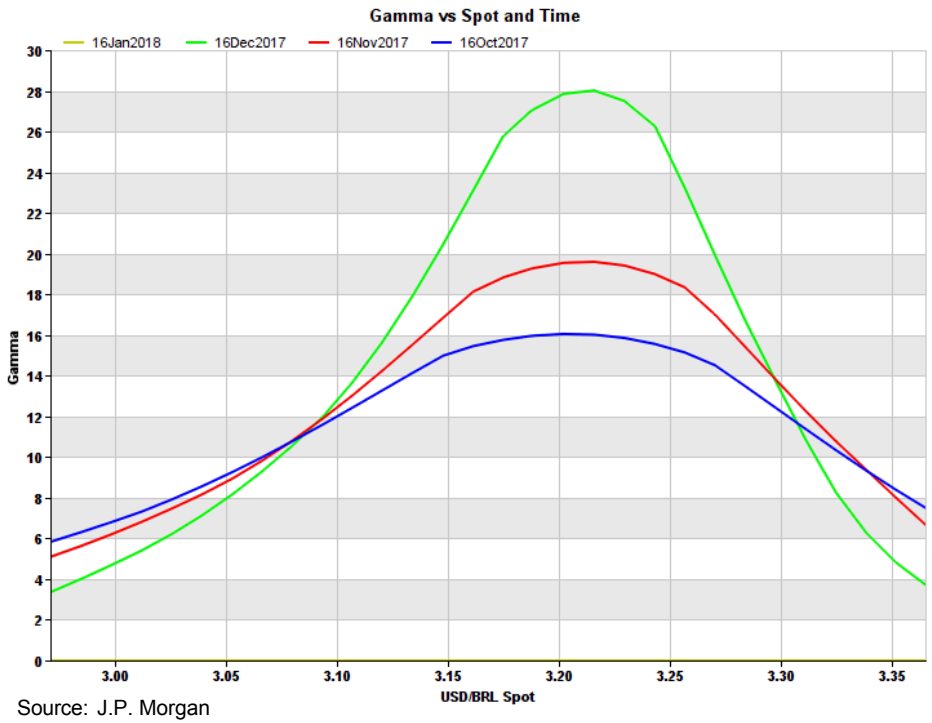
TRADING VOLATILITY AS AN ASSET CLASS

# GAMMA PROFILES

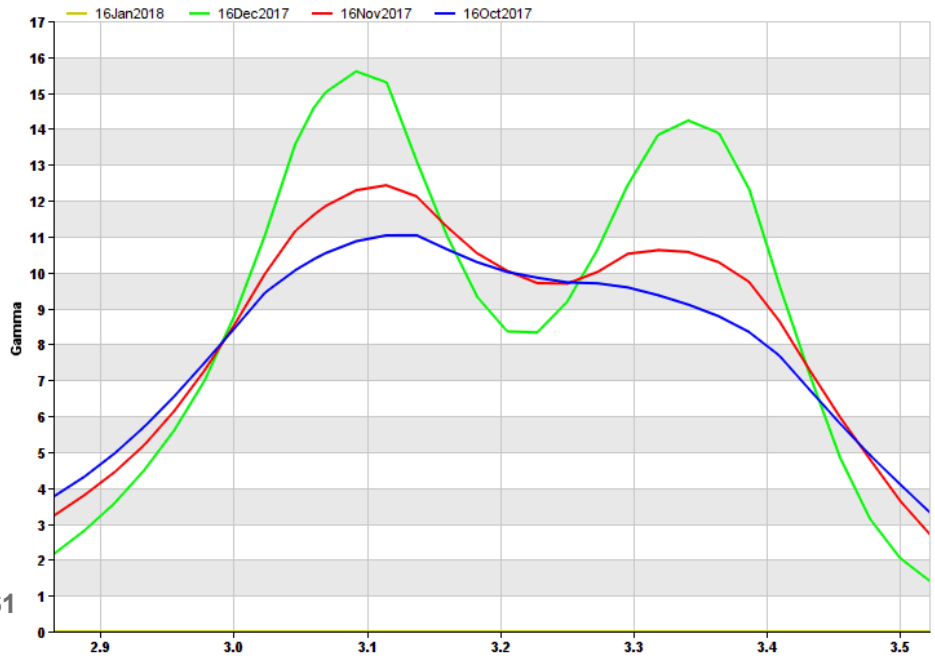
- 3M USD/BRL ATMF straddle vs. 3M 25 delta USD/BRL strangle (strikes ~ +/-4%)
- NDF @ 3.1863

| Name | 3M Strangle | 3M Straddle |
|---|---|---|
| Type | Strangle | Straddle |
| Market Date | Mon 16Oct2017 | Mon 16Oct2017 |
| Market State | Mkt2 | Mkt2 |
| FX Pair | USD/BRL Offshore | USD/BRL Offshore |
| Expiration Date | Tue 16Jan2018 [92d] | Tue 16Jan2018 [92d] |
| Settlement Date | Thu 18Jan2018 | Thu 18Jan2018 |
| Strike | | 3.1863 |
| Settlement Type | Cash | Cash |
| Settlement Currency | USD | USD |
| Expiration Cut | BRL | BRL |
| Option Type | Strangle | Straddle |
| Strangle Type | Broker | |
| Broker Delta | 25.00 | |
| Broker Vol | 11.556/12.408 | |
| Call Leg Strike | 3.3186 | |
| Put Leg Strike | 3.0600 | |
| | | |
| Quantity Currency | USD | USD |
| Quantity | 100 | 100 |
| Buy/Sell | b - JPM Buys | b - JPM Buys |
| Position | Per Leg | Per Leg |
| | | |
| Spot | 3.1501 | 3.1501 |
| Forward | 3.1863 | 3.1863 |
| Forward Point | 0.03624/0.03624 | 0.03624/0.03624 |
| Denominated Depo | 5.87 | 5.87 |
| Asset Depo | 1.35 | 1.35 |
| Vol for strike | | 11.334/12.013 |
| ATM Volatility | 11.674 | 11.674 |
| Call Leg Volatility | 12.716/13.521 | |
| Put Leg Volatility | 10.286/11.204 | |

Source: J.P. Morgan




Source: J.P. Morgan




Source: J.P. Morgan

TRADING VOLATILITY AS AN ASSET CLASS

# VOLATILITY SWAPS

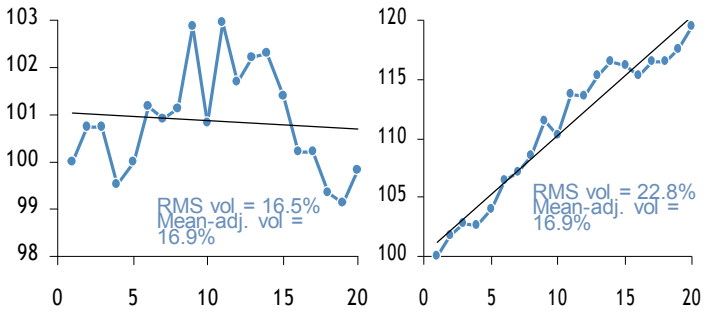
- In a trending environment straddles lose gamma and can no longer effectively monetize the difference between implied and realized volatility
- => own a series of strikes = ~ constant gamma profile
- Better: own (or sell) a volatility swap
- The payout of a volatility swap is simply:
  (Realized Vol –Vol Swap Strike) x vega amount
- The notional quantity is expressed in vega amounts
  - e.g. Sell $500,000 of 3M vega at 10.0%
- The volatility is typically determined by a set number of fixings
  - E.g. Spot rate sampled every business day at exactly 11:00 AM NYT from inception to expiry
- The **advantages** of a volatility swap versus a delta-hedged option:

  - **No need to delta hedge**

  - A constant gamma and vega profile across strikes

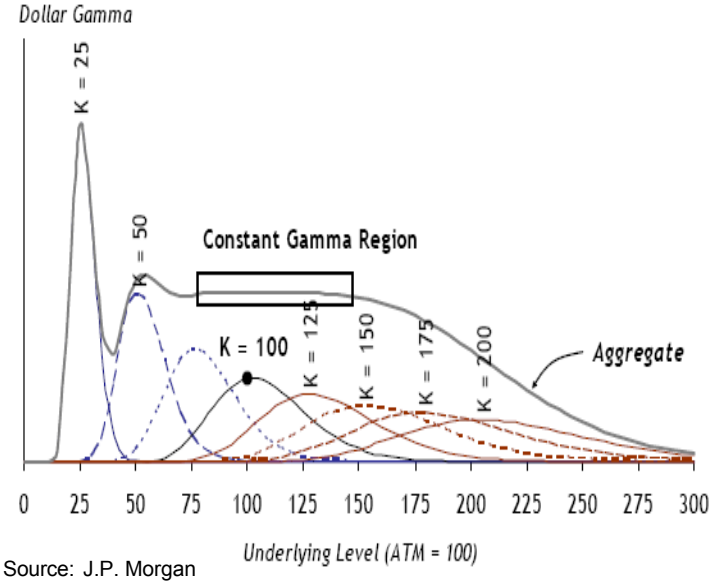
  - Ability to cleanly monetize the difference between implied and realized vol

**In a trendless market (left-had chart below), we can monetize realized volatility via a delta-hedged straddle, but in a trending environment, we lose our gamma along the way.**




Source: J.P. Morgan

**Owning a series of strikes in weights inversely proportional to the square of the strike gives an approximately constant gamma profile. Owning a volatility swap gives a payout with an exactly constant gamma profile.**




Source: J.P. Morgan



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# FORWARD VOLATILITY AGREEMENTS (FVAs)

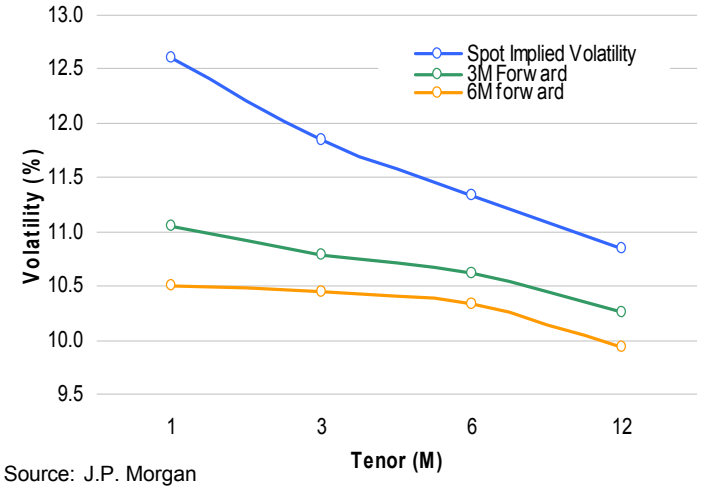
- Forward Volatility Agreement (FVA) is the right to buy or sell a fixed tenor option at a fixed point in the future.

$$\sigma^2_{n,m} * n_{daycount} = \sigma^2_{n+m} * \left(n_{daycount} + m_{daycount}\right) - \left(\sigma^2_{m} * m_{daycount}\right)$$

  where n and m are either months or years, i.e. $\sigma_{1,2}$ is 1m, 2m forward

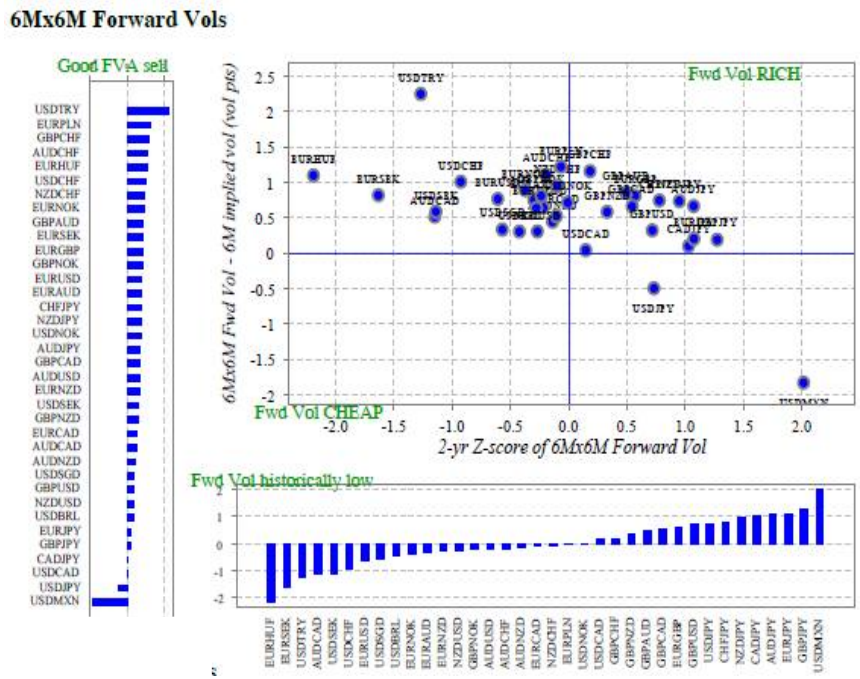
- Often considered to be a systematic buy when Spot Vol Curves are inverted, or downward sloping and systematic sells when Spot Vol Curves are steep, or upward sloping. Neither proposition is correct.
- Current Realized Vol, Structural concerns and the Macro regime's effect on the overall level of Volatility all need to be assessed when determining whether Forward Vol should be bought or sold.
- Provides exposure to forward implied volatility but without having to actively manage the Delta and Gamma.
- If the structure was created synthetically using Vanilla Options it would be in gamma neutral weights at inception, hence less 3m and more 6m, giving the net position the Vega exposure.

**Forward volatility vs. Spot/ Implied Volatility Curves**




Source: J.P. Morgan

**Forward Volatility Ranking**




Source: J.P. Morgan



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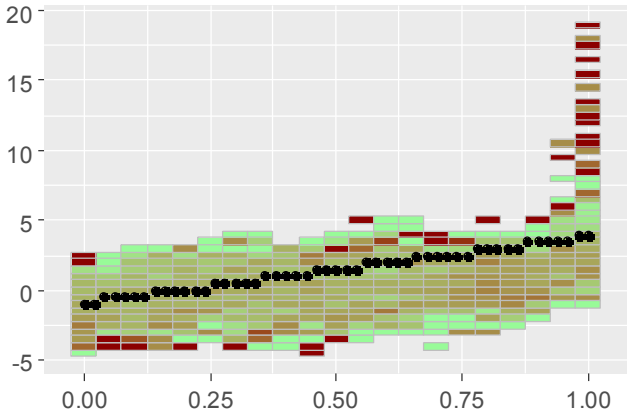
TRADING VOLATILITY AS AN ASSET CLASS

# Systematic FX vol trading – a machine learning approach

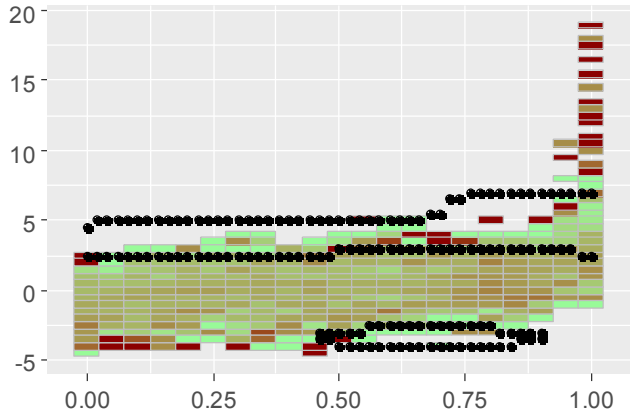
## G10 FX vols

**Logistic regression (predicted hit ratio of 70%)**




Source: J.P. Morgan

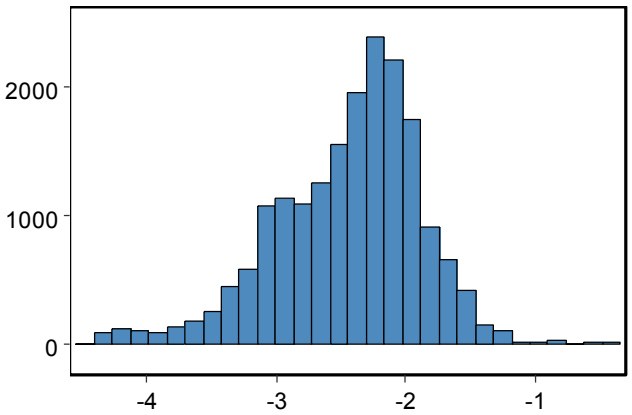
**SVM boundary of 70% overlaid on actual data**




Source: J.P. Morgan

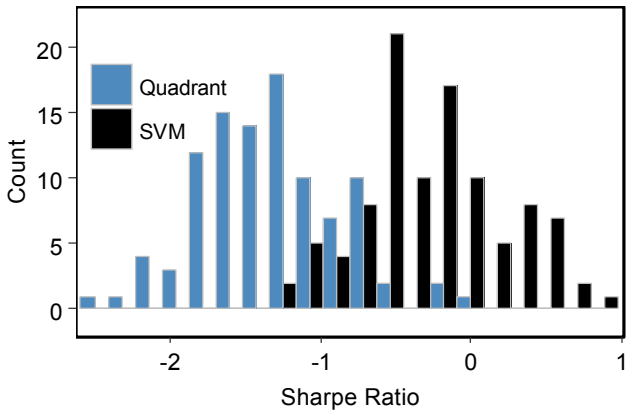
## EM FX vols

**Log of 1 Month Implied Volatility**




Source: J.P. Morgan

**Long 1M volatility**

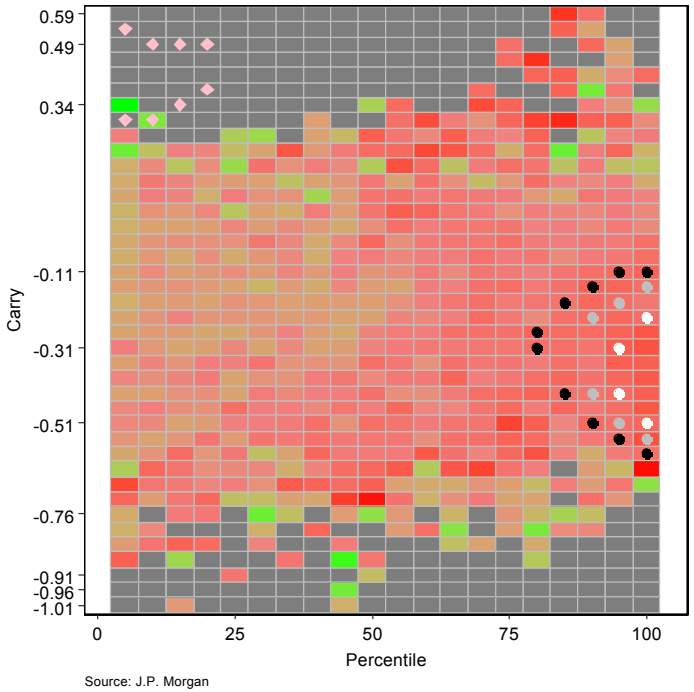



Source: J.P. Morgan

# Systematic FX vol trading – a machine learning approach cont'd

## Equity-G10 FX vols pair trading

**SVM decision boundaries for equity-FX variance pair trades**




Source: J.P. Morgan

| Long | Short | 1Y Variance Ratio (x) | 1Y Percentile | EWMA Realized Ratio (x) | SVM Ranking |
|---|---|---|---|---|---|
| CHF | NDX | 2.95 | 70% | 2.12 | 1 |
| NZD | SPX | 1.81 | 46% | 1.04 | 2 |
| JPY | NDX | 2.66 | 80% | 2.48 | 3 |
| NZD | NDX | 2.31 | 67% | 1.68 | 4 |
| EUR | SPX | 2.25 | 40% | 1.19 | 5 |
| CHF | SPX | 2.31 | 43% | 1.31 | 6 |
| JPY | AS51 | 1.80 | 68% | 1.55 | 7 |
| CHF | EEM | 3.09 | 63% | 3.04 | 8 |
| SEK | SPX | 1.72 | 15% | 0.85 | 9 |
| NZD | EEM | 2.42 | 53% | 2.41 | 10 |
| EUR | NDX | 2.88 | 56% | 1.92 | 11 |
| CAD | NDX | 2.83 | 55% | 1.88 | 12 |
| CAD | SPX | 2.21 | 30% | 1.17 | 13 |
| EUR | HSI | 2.85 | 57% | 2.68 | 14 |
| SEK | NDX | 2.20 | 38% | 1.37 | 15 |
| AUD | SPX | 1.84 | 28% | 1.03 | 16 |
| JPY | SPX | 2.08 | 57% | 1.54 | 17 |
| CHF | AS51 | 1.99 | 43% | 1.32 | 18 |
| AUD | NDX | 2.36 | 52% | 1.67 | 19 |
| CHF | NKY | 2.78 | 59% | 2.31 | 20 |

Source: J.P. Morgan

# Agenda



J.P.Morgan

# FX-options-based signals as source of market intelligence for FX spot trading

- Exchange rate predictability using option-market information to the extent that options embed forward looking information
- The heuristics that have historically been able to deliver meaningful intelligence about FX spot dynamics:
  - at-the-money (ATM) volatility, realized volatility, ATM – realized volatility risk premia, vol curve slopes, risk reversals and butterflies as well as their simple mathematical transformations (z-scores, monthly changes, … )
- G10 & EM ccy pairs (BRL, CLP, COP, MXN, CNY, IDR, INR, KRW, MYR, SGD, TWD, HUF, ILS, PLN, RUB, TRY, ZAR)

**Option-market configurations tested as FX spot predictors**

| Characteristics | Specifications |
|---|---|
| Option tenors | 1m, 3m, 6m, 9m, 1y |
| N of pairs in portfolio | 1, 3 |
| currency population | G10 (9 USD pairs) |
| | EM (17 most liquid USD pairs) |
| | G10 + EM (tot of 26 USD pairs) |
| transformation | 1-y zscore |
| | period/period change & % change |
| | change in 1-y zscore |
| | ratio to ATM |
| | change in 1-y z-score of ratio |
| type of signal | ATM vols |
| | 1-mo trailing real vol: rmsvol (daily close data) |
| | high freq real vol (hourly): 1 wk & 4 wk trailing |
| | risk reversals |
| | butterflies |
| | vol curves |
| Tot # of signals tested | 207 |
| Tot # of portfolios | 1242 |

Source: J.P.Morgan

**Vol signals performance summary in terms of Sharpe Ratio**

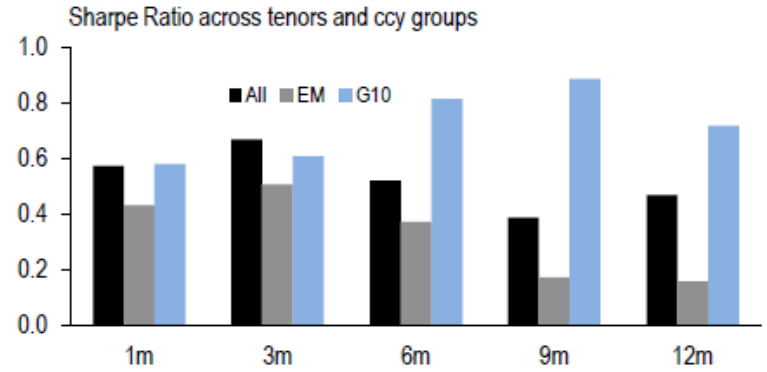
| Signal | Trading rule | Sharpe |
|---|---|---|
| **ATM: risk aversion play** | | |
| Δm/m in 1-year ATM z-score | buy (sell) FX with largest downtick | 0.7 |
| %m/m in ATM vols | (uptick) in vol signal | 0.5 |
| **realized: risk on/ risk off** | | |
| %m/m in realized vol | buy (sell) FX with largest downtick | 0.4 |
| Δm/m in realized/ATM ratio | (uptick) in realizd vol or realizd | 0.4 |
| Δm/m in z-score of realized/ATM | vol/ATM ratio | 0.5 |
| realized/ATM ratio | buy (sell) FX with lowest (highest) | 0.4 |
| z-score of realized/ATM | realized vol/ATM ratio | 0.6 |
| **risk reversals: flow driven** | | |
| %m/m in RR | buy (sell) FX with largest downtick | 0.3 |
| Δm/m in RR z-score | (uptick) in RR/ATM ratio, where RR is | 0.8 |
| Δm/m in RR/ATM z-score | USD/CCY call - USD/CCY put | 0.5 |
| **B-fly: risk aversion play** | | |
| B-fly/ATM | buy (sell) FX with lowest (highest) B-fly vol/ATM ratio | 0.7 |
| %m/m in B-fly vols | buy (sell) FX with largest downtick (uptick) in B-fly vol/ATM ratio | 0.5 |
| **vol curves** | | |
| Δm/m vol curve | buy (sell) FX with quickest | 0.5 |
| Δm/m of vol curve z-score | normalization (inversion) in vol curve | 0.5 |

Source: J.P.Morgan

# ATM, risk premium and vol curve show tradable spot market intelligence

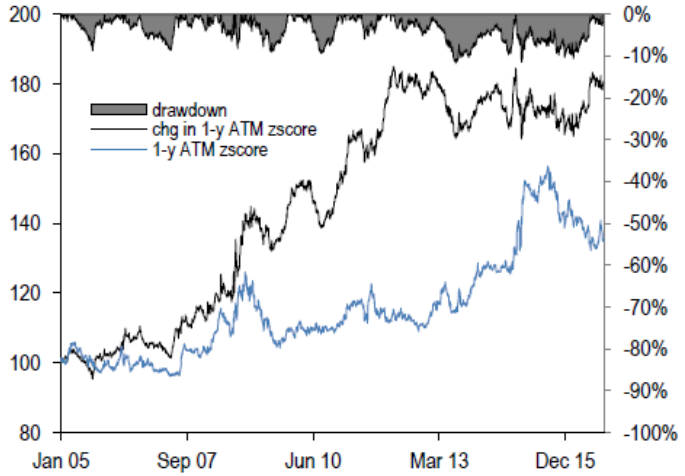
OPTION MARKETS AS A SOURCE OF INTELLIGENCE FOR SPOT MARKETS

**Performance statistics for signal based on monthly changes in one-year ATM z-score across tenors**



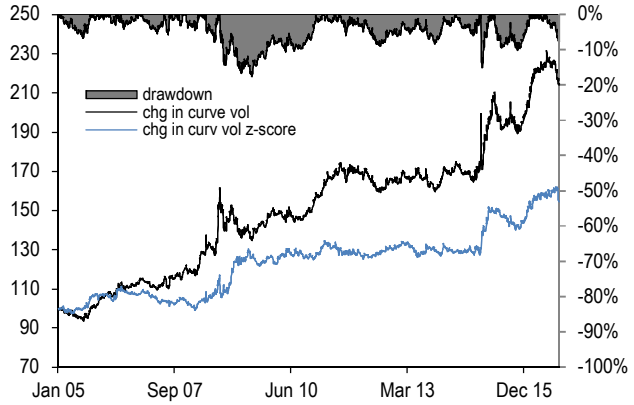

Source: J.P. Morgan

Cumulative P/L for signals based on ATM vol: change in z-score (S.R. of 0.67) vs. level of ATM z-score (S.R. 0.36).



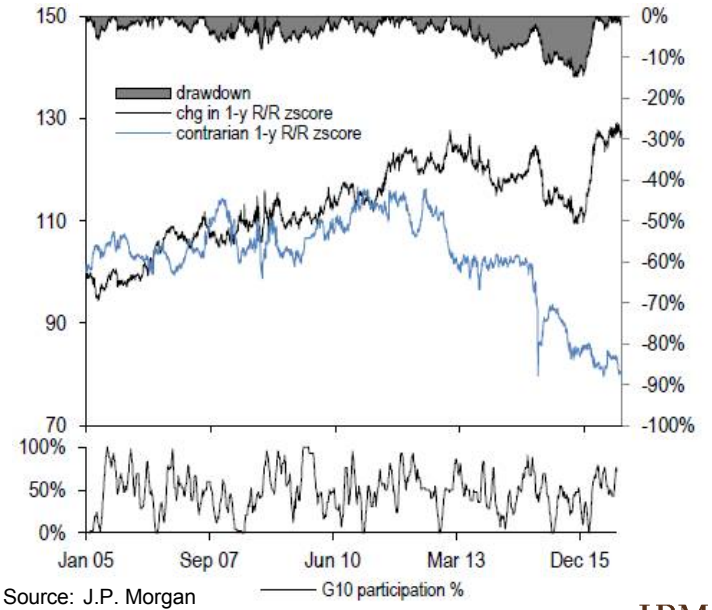

Source: J.P. Morgan

**Cumulative P/L for signals based on vol curve: momentum change in vol curve and the corresponding change in vol curve z-score**




Source: J.P. Morgan

**Cumulative P/L for signals based on R/R vol**




Source: J.P. Morgan



J.P.Morgan

## Some redundancy | performance only skimming the surface

*cross correlations of returns*

| | | chg of 1-y ATM z-score | % chg in ATM vols | chg in real/ATM | % chg in realized vols | chg in 1-y z-score of real/ATM | real/ATM | 1-y real/ATM z-score | % chg in RR | chg in 1-y RR z-score | chg in 1-y RR/ATM z-score | Bfly/ATM | % chg in BF vols | chg in vol curve | chg in vol curve 1-y z-score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ATM** | **chg of 1-y ATM z-score** | | | | | | | | | | | | | | |
| | % chg in ATM vols | 48% | | | | | | | | | | | | | |
| **Realized vol** | **chg in real/ATM** | 9% | 16% | | | | | | | | | | | | |
| | % chg in realized vols | 24% | 48% | 51% | | | | | | | | | | | |
| | chg in 1-y z-score of real/ATM | 11% | 9% | 66% | 39% | | | | | | | | | | |
| | real/ATM | 6% | 17% | 39% | 39% | 29% | | | | | | | | | |
| | 1-y real/ATM z-score | 10% | 15% | 40% | 36% | 41% | 48% | | | | | | | | |
| **RR** | % chg in RR | 20% | 41% | 10% | 36% | 4% | 16% | 16% | | | | | | | |
| | chg in 1-y RR z-score | 20% | 16% | 10% | 14% | 9% | -1% | 5% | 53% | | | | | | |
| | chg in 1-y RR/ATM z-score | 5% | 3% | 6% | 5% | 1% | 4% | 5% | 44% | 57% | | | | | |
| **Bfly** | Bfly/ATM | -3% | 0% | 0% | -4% | -3% | -20% | -2% | 3% | 5% | 3% | | | | |
| | % chg in BF vols | 17% | 41% | 0% | 29% | -1% | 9% | 3% | 35% | 8% | 7% | 12% | | | |
| **Vol curve** | chg in vol curve | 40% | 68% | 16% | 44% | 9% | 18% | 19% | 37% | 15% | 1% | 1% | 36% | | |
| | **chg in vol curve 1-y z-score** | 48% | 38% | 14% | 26% | 14% | 8% | 13% | 16% | 14% | 3% | -4% | 16% | 47% | |
| | **Optimal selection** | **9%** | 6% | **11%** | 11% | 4% | 10% | 12% | 9% | 6% | 4% | -2% | 0% | 11% | **7%** |

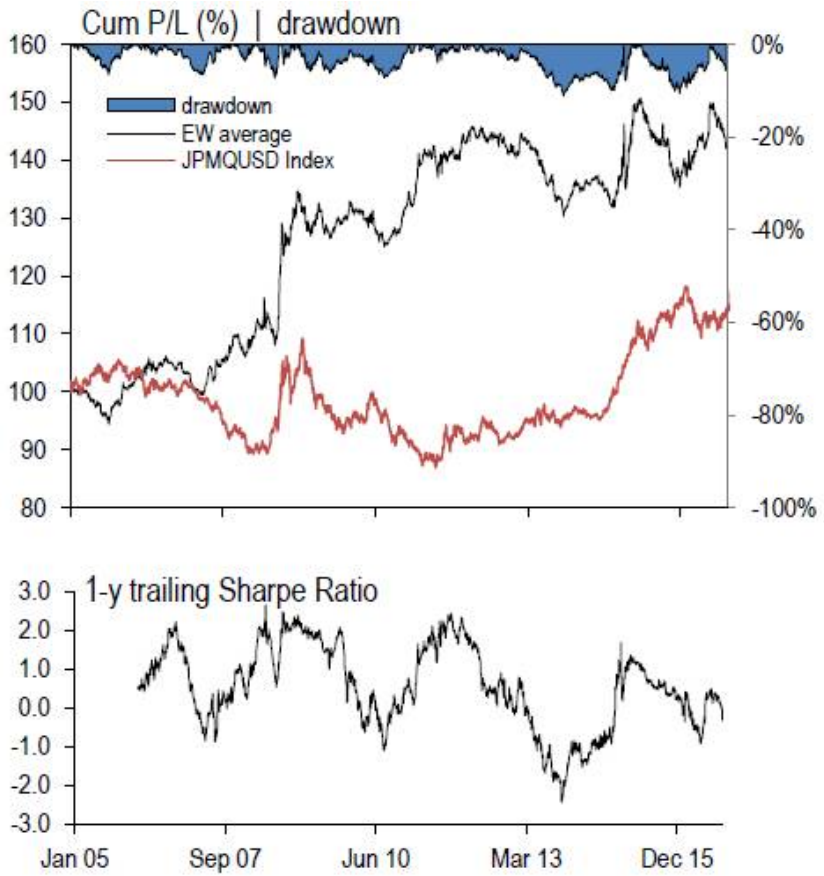
## Transaction costs trim returns, increase volatility

| (LDN) | 12PM | 1PM | 2PM | 3PM | 4PM | 5PM | 6PM | 7PM | 8PM | 9PM | 10PM | 11PM | 12AM | 1AM | 2AM | 3AM | 4AM | 5AM | 6AM | 7AM | 8AM | 9AM | 10AM | 11AM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUDUSD | 4.6 | 4.6 | 4.5 | 4.6 | 4.5 | 4.5 | 4.6 | 4.7 | 4.6 | 4.7 | 6.1 | 5.2 | 4.5 | 4.5 | 4.6 | 4.5 | 4.5 | 4.5 | 4.5 | 4.6 | 4.6 | 4.5 | 4.5 | 4.5 |
| EURUSD | 2.4 | 2.4 | 2.5 | 2.4 | 2.4 | 2.4 | 2.5 | 2.5 | 2.5 | 2.5 | 3.5 | 3.3 | 2.5 | 2.5 | 2.5 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.5 | 2.5 | 2.5 | 2.4 |
| GBPUSD | 3.0 | 3.0 | 2.9 | 3.0 | 3.0 | 2.9 | 3.0 | 3.0 | 3.0 | 3.1 | 4.3 | 4.3 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| USDCAD | 3.6 | 3.6 | 3.6 | 3.6 | 3.4 | 3.5 | 3.6 | 3.1 | 3.6 | 3.7 | 5.2 | 5.5 | 3.8 | 3.7 | 3.7 | 3.7 | 3.7 | 3.4 | 3.7 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 |
| USDCHF | 6.1 | 6.1 | 6.1 | 6.2 | 6.1 | 6.0 | 5.9 | 5.9 | 5.9 | 6.1 | 8.7 | 7.9 | 6.9 | 6.7 | 6.3 | 6.2 | 6.2 | 6.2 | 6.2 | 6.1 | 6.2 | 6.2 | 6.1 | 6.1 |
| USDJPY | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 4.2 | 3.7 | 3.3 | 3.3 | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 |
| USDNOK | 7.7 | 7.6 | 7.8 | 8.0 | 7.6 | 8.5 | 8.8 | 9.8 | 9.2 | 9.7 | 13.5 | 14.0 | 11.2 | 10.7 | 10.4 | 10.1 | 10.2 | 10.1 | 10.0 | 9.6 | 8.3 | 8.7 | 7.9 | 7.7 |
| USDSEK | 6.2 | 6.1 | 6.2 | 6.4 | 5.9 | 7.3 | 7.6 | 7.8 | 7.8 | 8.4 | 12.2 | 13.0 | 10.0 | 9.5 | 9.0 | 8.7 | 8.7 | 8.4 | 8.1 | 8.0 | 6.7 | 6.7 | 6.3 | 6.2 |
| NZDUSD | 5.9 | 5.9 | 5.9 | 6.0 | 5.9 | 5.8 | 6.3 | 6.8 | 6.3 | 6.3 | 8.8 | 7.3 | 6.0 | 5.9 | 6.0 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 | 5.9 |
| USDBRL | 4.8 | 4.5 | 4.1 | 4.1 | 4.0 | 4.2 | 4.3 | 3.9 | 4.4 | 4.7 | 5.1 | 5.1 | 5.1 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.0 |
| USDCLP | 10.8 | 9.9 | 8.2 | 7.6 | 7.6 | 8.6 | 9.0 | 9.2 | 11.3 | 11.9 | 13.7 | 14.4 | 13.9 | 13.9 | 14.1 | 14.2 | 14.4 | 14.4 | 14.6 | 14.6 | 11.7 | 11.8 | 11.8 | 11.7 |
| USDCOP | 7.7 | 8.8 | 9.1 | 7.6 | 7.2 | 7.2 | 7.6 | 8.9 | 7.5 | 7.8 | 8.4 | 8.1 | 8.2 | 8.2 | 8.2 | 8.0 | 7.8 | 7.8 | 7.9 | 7.9 | 7.7 | 7.7 | 7.6 | 7.5 |
| USDMXN | 3.9 | 3.1 | 2.8 | 2.9 | 2.1 | 2.4 | 2.6 | 3.5 | 2.9 | 3.7 | 7.5 | 9.0 | 7.1 | 6.5 | 6.3 | 6.0 | 5.9 | 5.8 | 5.8 | 5.4 | 4.7 | 4.4 | 4.3 | 4.2 |
| USDCNH | 2.7 | 2.6 | 2.6 | 2.6 | 2.9 | 2.7 | 3.0 | 3.1 | 3.1 | 3.4 | 4.3 | 5.4 | 4.2 | 3.0 | 2.3 | 2.2 | 2.2 | 2.3 | 2.2 | 2.2 | 2.3 | 2.3 | 2.3 | 2.4 |
| USDIDR | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 5.2 | 8.0 | 8.0 | 8.0 | 8.2 | 8.0 | 8.0 | 8.3 | 8.5 | 8.4 | 8.3 | 8.7 | 8.6 | 8.2 | 7.9 | 7.9 | 7.9 |
| USDINR | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.6 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| USDKRW | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.9 | 3.5 | 3.5 | 3.5 | 3.5 | 4.4 | 4.3 | 3.8 | 3.7 | 3.7 | 3.7 | 3.7 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| USDMYR | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.3 | 11.5 | 11.8 | 11.0 | 9.1 | 8.8 | 10.6 | 10.8 | 10.2 | 10.0 | 10.2 | 10.4 | 10.6 |
| USDSGD | 5.0 | 4.9 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.2 | 6.6 | 6.7 | 5.4 | 5.0 | 5.0 | 5.0 | 5.0 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| USDTWD | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 2.9 | 3.2 | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 | 3.4 | 3.0 | 2.1 | 2.2 | 2.6 | 2.5 | 2.3 | 3.2 | 3.2 | 3.2 |
| USDHUF | 12.6 | 12.7 | 12.7 | 12.7 | 12.6 | 13.4 | 14.3 | 14.3 | 14.8 | 15.8 | 20.4 | 22.9 | 22.1 | 21.0 | 20.5 | 20.1 | 19.9 | 19.8 | 19.5 | 17.5 | 13.2 | 12.7 | 12.7 | 12.7 |
| USDILS | 6.1 | 6.0 | 6.6 | 6.6 | 5.1 | 9.2 | 10.8 | 11.1 | 11.4 | 13.7 | 20.7 | 23.3 | 25.8 | 25.3 | 25.0 | 24.8 | 24.6 | 24.2 | 16.4 | 9.0 | 6.5 | 5.9 | 5.8 | 6.1 |
| USDPLN | 7.5 | 7.6 | 7.6 | 7.8 | 7.5 | 8.9 | 10.2 | 11.7 | 11.1 | 11.9 | 17.5 | 19.9 | 19.0 | 18.2 | 17.7 | 17.2 | 16.8 | 16.7 | 16.6 | 13.8 | 8.4 | 7.7 | 7.5 | 7.6 |
| USDRUB | 6.3 | 6.4 | 6.6 | 7.1 | 21.6 | 22.3 | 23.7 | 40.6 | 25.3 | 32.3 | 37.9 | 36.8 | 39.4 | 39.3 | 39.8 | 40.0 | 39.8 | 39.3 | 31.9 | 25.4 | 9.7 | 6.4 | 6.2 | 6.2 |
| USDTRY | 3.7 | 3.7 | 3.9 | 4.0 | 3.8 | 5.8 | 6.6 | 8.1 | 7.6 | 8.6 | 12.7 | 13.7 | 12.7 | 11.9 | 11.2 | 10.9 | 10.4 | 10.2 | 8.5 | 5.6 | 4.1 | 3.7 | 3.7 | 3.8 |
| USDZAR | 9.8 | 9.6 | 9.7 | 9.8 | 9.4 | 18.3 | 18.5 | 16.4 | 18.9 | 19.7 | 24.3 | 23.5 | 20.7 | 19.2 | 17.0 | 15.9 | 15.0 | 14.1 | 19.3 | 18.7 | 10.1 | 9.9 | 9.8 | 9.8 |

Source: J.P. Morgan

# Putting it all together: a composite signal

**Equal weighted average signal from the three favored signals**




Source: J.P. Morgan

**Current ranking of currency pairs in G10+EM population based on three signals: Δm/m in 1) ATM z-score, 2) real vol/ATM ratio, 3) vol curve**

| | Δ 1-y ATM z-score of 3M ATM vol | Δ 3M real vol/ATM ratio | Δ 3M-1Y vol surface slope | |
|---|---|---|---|---|
| GBP | -1.27 | -0.11 | -0.47 | |
| TRY | -1.14 | -0.08 | -1.09 | |
| INR | -1.01 | -0.26 | -0.10 | Buy |
| HUF | -0.49 | -0.18 | -0.05 | |
| RUB | -0.75 | -0.15 | 0.01 | |
| ILS | -1.06 | 0.13 | -0.17 | |
| ZAR | -3.06 | 0.91 | -1.64 | |
| JPY | -0.82 | 0.10 | -0.11 | |
| SEK | -0.87 | 0.15 | -0.27 | |
| KRW | -0.46 | -0.32 | 0.06 | |
| CLP | -1.55 | 0.49 | -0.97 | |
| CHF | -0.46 | 0.13 | -0.06 | |
| EUR | -0.27 | -0.16 | 0.17 | |
| NOK | -0.43 | -0.03 | 0.05 | |
| PLN | -0.39 | 0.04 | -0.03 | |
| AUD | -0.72 | 0.26 | 0.19 | |
| NZD | -0.73 | 0.23 | 0.25 | |
| SGD | 0.33 | 0.10 | 0.19 | |
| MYR | 0.37 | -0.17 | 0.92 | |
| IDR | -0.02 | 0.01 | 0.42 | |
| MXN | 0.27 | 0.15 | 0.23 | |
| BRL | -0.23 | 0.16 | 0.26 | |
| CAD | 0.51 | -0.05 | 0.49 | |
| CNY | -0.09 | 0.18 | 0.26 | Sell |
| TWD | 0.48 | 0.32 | 0.16 | |
| COP | 0.43 | 0.20 | 0.40 | |

Source: J.P. Morgan

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