

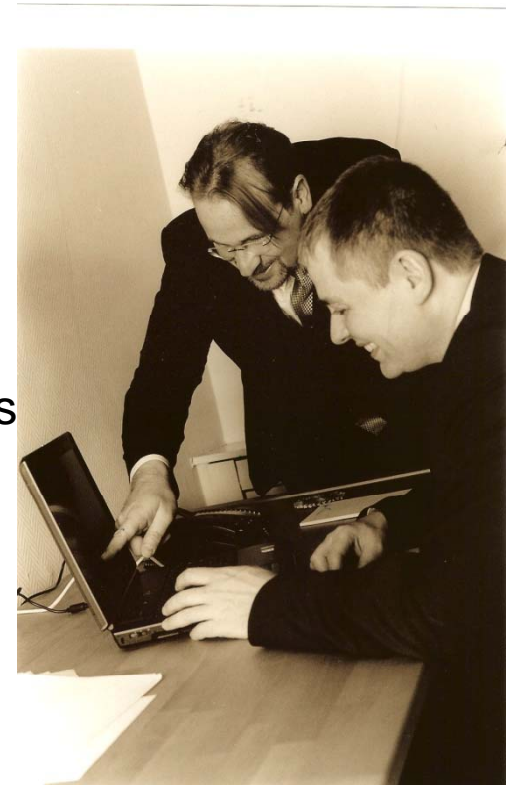
- ▲ Founded Nov 2003
- ▲ Team: Prof. Dr. Uwe Wystup, Andreas Weber – former front office financial engineering/structuring FX Options desk Commerzbank ++ 3 Quants
- ▲ International Client Base
- ▲ Key Expertise: Financial Markets Models, Implementation in C++/Mathematica/VBA



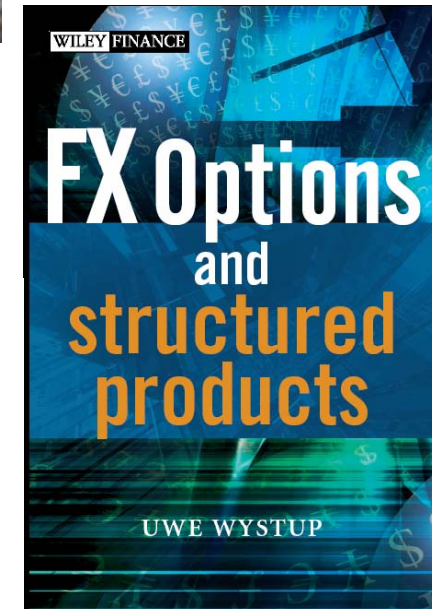
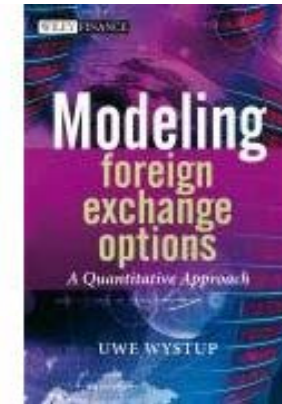
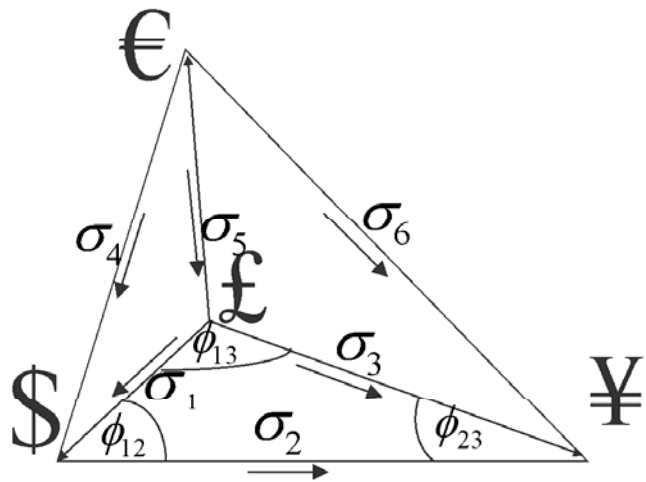
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FX Option Pricer

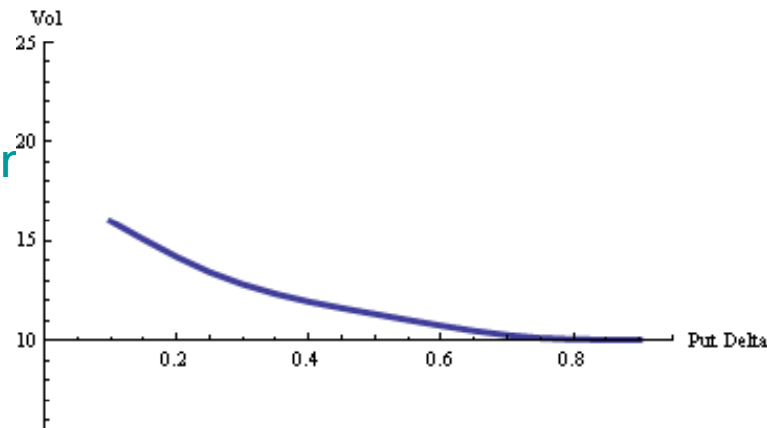
As DLL, XLL, LIB, code

Vanilla, Digitals, First Generation
Barriers / Touches

Exotic Barriers, Faders, Target
Redemption Forwards, Shout
Forwards

Smile Building / Interpolation

JPYUSD 1M Vol on 2003-10-03



MathFinance: FX Options Library

Available Models:
Stochastic Vol, Jumps,
Mixed, Vanna-Volga

Many traders prefer the simple and fast vanna-volga pricing approach

Observation

Price is often far from theoretical value (**TV**)

Solution

Include the cost of risk managing the volatility exposure (**Overhedge**)

References

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Castagna, A. and Mercurio, F. (2007). The Vanna-Volga Method for Implied Volatilities. Risk, Jan 2007, pp. 106-111.
Bossens, Rayée, Skantzos, Deelstra: Vanna-Volga methods applied to FX derivatives: from theory to market practice. Centre Emile Bernheim Working Paper No. 09/016. Solvay Brussels School of Economics and Management. 2009



Vanna-volga pricing idea

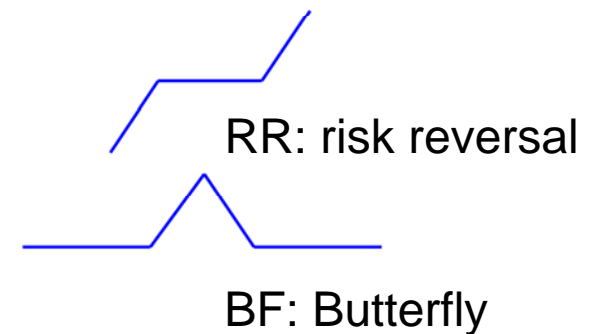
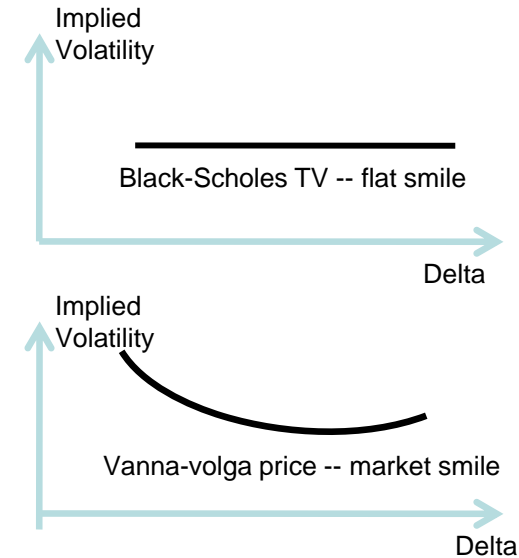
To determine the market price of an exotic option, we start with a TV (theoretical value), which is the value in the Black-Scholes model assuming normal returns and constant interest rates and volatilities.

However, in real markets, rates and volatilities change over time. For FX options up to 3 years the volatility change risk is dominating and must be hedged.

Traders hedge the following risks:

- 1) At-the-money vega or parallel shift of the volatility smile with liquid at-the-money vanilla options
- 2) Skew of the smile with Risk Reversals. The measure for the skew is vanna (or $d\text{vega}/d\text{spot}$). The traded risk reversal hedges the vanna.
- 3) Convexity of the smile with Butterflies/Strangles. The measure for convexity is volga (or $d\text{vega}/d\text{vol}$). The traded butterfly hedges the volga

The **overhedge** of the hedges 2) and 3) are computed when hedging an exotic option and added to the TV. Overhedge is the difference of the market price and the TV. 1) has a zero overhedge being at-the-money.



Vanna-volga in practice

Market price of an exotic Option
= TV

- + $p \cdot \text{vanna of the Option} \cdot \text{OH RR} / \text{vanna RR}$
- + $p \cdot \text{volga of the Option} \cdot \text{OH BF} / \text{volga BF}$

Example USD/JPY one-touch

$\triangle = 38.2\%$

$\triangle + p \cdot [-9.0 \cdot (-0.15\%) / 4.5]$

$\triangle + p \cdot [-1.0 \cdot 0.27\% / 0.035]$

$\triangle = 38.2\% + p \cdot [0.3\% - 7.7\%]$

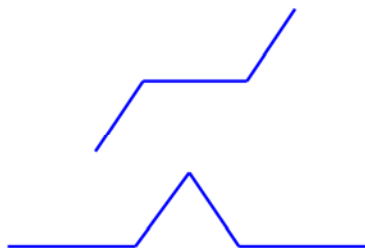
$\triangle = 38.2\% - p \cdot 7.4\%$

Survival probability $p = 61.8\%$

Overhedge: $61.8\% \cdot -7.4\% = -4.6\%$

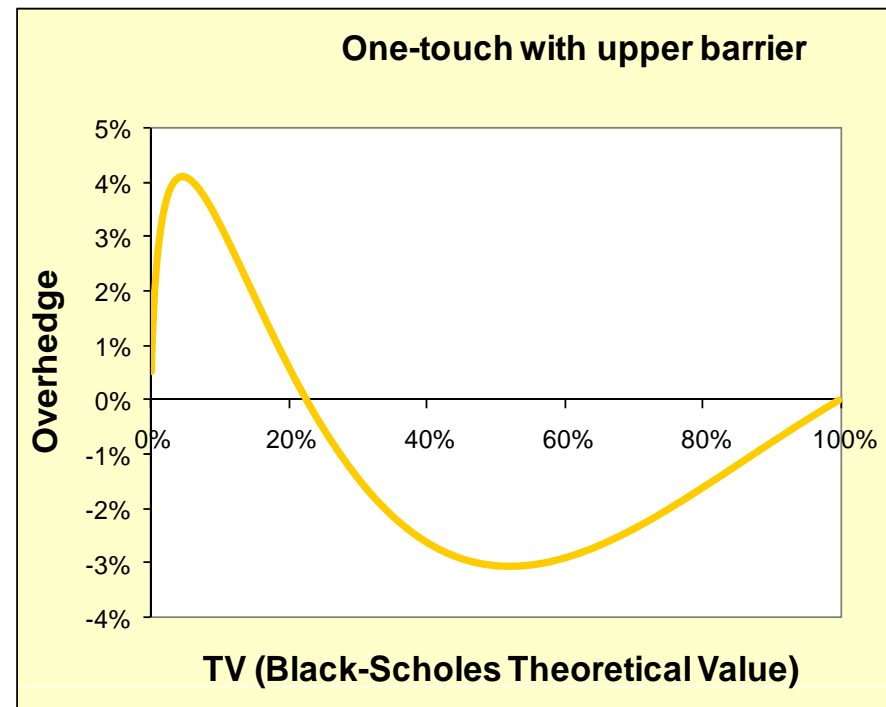
Market price: $38.2\% - 4.6\% = 33.6\%$

Hedge of a long position: sell 2 RR and 28 BF



RR: risk reversal

BF: Butterfly



Market data: EUR/USD 17 July 2002 1.0045 EUR 3.33% USD 1.76%, 3 M ATM vol 11.85%, RR 1.25%, BF 0.25%