# Managing Risk of Exotic Products - An Illustrative Example

When trading European options, great attention is paid to the gamma on a trading book. The gamma measures the rate of change of an option delta as the underlying changes, and is given by the second derivative of the option price with respect to the asset price.

When trading exotic products on multiple underlyings an additional concept of cross gamma is required. This measures the change in delta of one asset as the underlying price of a different asset changes.   Any product which is composed of multiple underlyings is exposed to cross-gamma risk. This includes commonly traded basket options, and best of/worst of options. To consider the relative importance of cross-gamma it is worth considering an illustrative example using a geometric basket option.[1] For this option type the value of the basket of underlyings is the geometric average of the underlying asset values. Mathematically the payoff at expiry of this type of product is given by

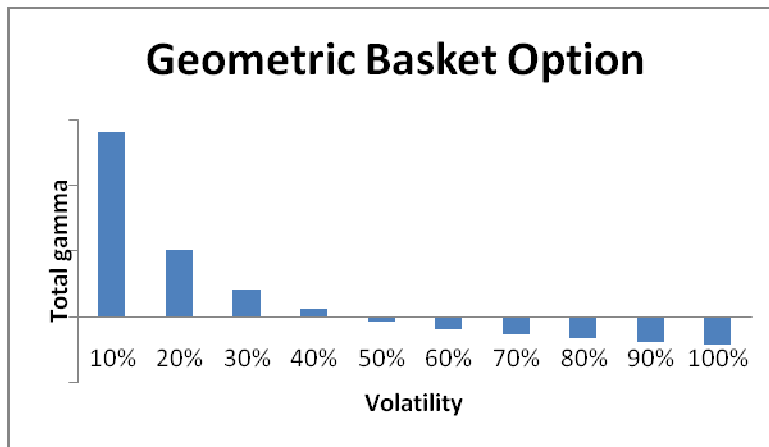$$\max\left(\sqrt[n]{S_1 S_2 \ldots S_n} - K, 0\right)$$

In the following chart we plot the amount of risk explained by the gamma and the cross gamma of this type of option as we vary the number of underlying assets
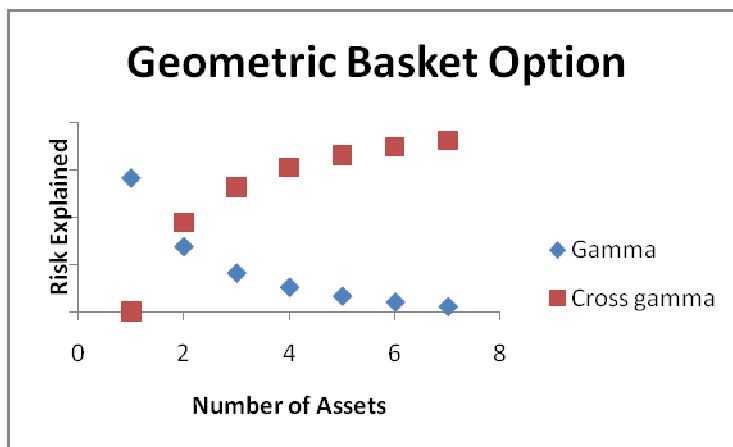
From this chart we can see that as the number of assets increases the cross gamma becomes more important than the gamma. For this type of product and for other multi-asset products such as basket and rainbow options, bestof/worstof options, PRDC notes, and autocallable products on multiple underlyings, an understanding of cross gamma is an important part of risk management.

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[1] Geometric options are far less frequently traded than the regular arithmetic basket option, however they share many of the same characteristics but are significantly easier to analyse mathematically.

For the same option with 4 underlyings we plot the value of gamma as a function of the volatility of the underlying assets.

Geometric Basket Option

(chart: Total gamma on the vertical axis, Volatility on the horizontal axis with values 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%)

In this case we can see that the gamma changes sign as the volatility varies, making this a difficult variable to hedge practically. Other examples problematic products includes multi-asset cliquets where correlation exposure changes sign with spot, or barrier products where vega exposure changes with movements in the underlying.

In this course we study the types of risk management techniques required for exotic products in order to capture the strange behaviours exhibited in cases like the example above. In particular we examine how common risk measures can vary dramatically and even change sign when other external pieces of market data change.

After attending this course a participant will be able to

- Understand risk management techniques required for exotic products

- Devise robust strategies for dealing with complexity in trading books

- Assess the impact of illiquidity on a trading book

- Understand the risk no captured by the common pricing models

- Design scenarios to better understand the behaviour of trading books

- Understand the relationship between choice of model and market exposure

- Assess how correlation impacts both trading and risk management of exotic positions.