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# Spread option using Gaussian quadrature

created by **Thijs van den Berg**

$$C_{SP} \approx \sum_i w_i n(x_i) C_{BS}(S', X', \sigma', Y_1, t)$$
$$S' = S_1 \exp\left(\rho\sigma_1\sqrt{t}x_i - \frac{1}{2}\sigma_1^2\rho^2 t\right)$$
$$X' = S_2 \exp\left(\sigma_2\sqrt{t}x_i + (Y_2 - \frac{1}{2}\sigma_2^2)t\right) + X$$
$$\sigma' = \sigma_1\sqrt{1-\rho^2}$$

This equation uses the Gauss-Legendre quadrature to approximate the value of a spread option. The Gauss-Legendre quadrature abscissas (Xi) are rescaled in the range -4 to +4. The equation is unbiased and gives very accurate results, typical 6 digit accuracy with 16 quadrature points. The method was describes by K. Ravindran in his paper "Low-fat spreads" (1993) RISK 6 (10) 56--57.

## Symbol list:

| | |
|---|---|
| $C_{SP}$ | Price of the spread call option with payoff max(S1-S2-X,0) |
| $C_{BS}$ | Price of a Black & Scholes vanilla option |
| $w_i$ | Gauss-Legendre quadrature weights |
| $x_i$ | Gauss-Legendre quadrature abscissas in the range -4 to +4 |
| $S_1$ | Value of the long underlying |
| $\sigma_1$ | Volatility of the long underlying |
| $Y_1$ | Yield of the long underlying |
| $S_2$ | Value of the short underlying |
| $\sigma_2$ | Volatility of the short underlying |
| $Y_2$ | Yield of the short underlying |
| $\rho$ | Correlation between the underlyings |
| X | Strike |
| t | Time till expiration |
| $n(x)$ | Normal density function |