

Historical Open-High-Low-Close Volatility: Garman and Klass (Yang Zhang)

created by **Thijs van den Berg**

$$\sigma = \sqrt{\frac{Z}{n} \sum \left[\left(\ln \frac{O_i}{C_{i-1}} \right)^2 + \frac{1}{2} \left(\ln \frac{H_i}{L_i} \right)^2 - (2 \ln 2 - 1) \left(\ln \frac{C_i}{O_i} \right)^2 \right]}$$

Yang and Zhang derived an extension to the Garman Glass historical volatility estimator that allows for opening jumps. It assumes Brownian motion with zero drift. This is currently the preferred version of open-high-low-close volatility estimator for zero drift and has an efficiency of 8 times the classic close-to-close estimator. Note that when the drift is nonzero, but instead relative large to the volatility, this estimator will tend to overestimate the volatility.

Symbol list:

σ	Volatility
Z	Number of closing prices in a year
n	Number of historical prices used for the volatility estimate
O_i	The opening price
H_i	The high
L_i	The low
C_i	The close