FINANCE WEB APP
SHIMKO THEORETICAL

This function computes the theoretical bounds of probability

This section regards a method implemented by D. Shimko in (1993) “Bounds of probability Risk (Concord, NH), 6(4), 33–37”. The outputs of this procedure are index probability distribution (returns and prices) and the associated implied volatilities, starting from market data of an european option. It is called “Shimko Theoretical" since it skips the first step (of the procedure detailed by D.Shimko) in which there is the computation of Risk Free and dividend yield using put-call-parity and the second step where implied volatilities is determined throught Black and Sholes formula. The whole procedure that starts from market data is reproduced in the section “Shimko Market”.

Form Field

There are 4 different groups (fig 1 Shimko Theorethical Input Form) of input parameters. Here we are going to explain the features of each one.

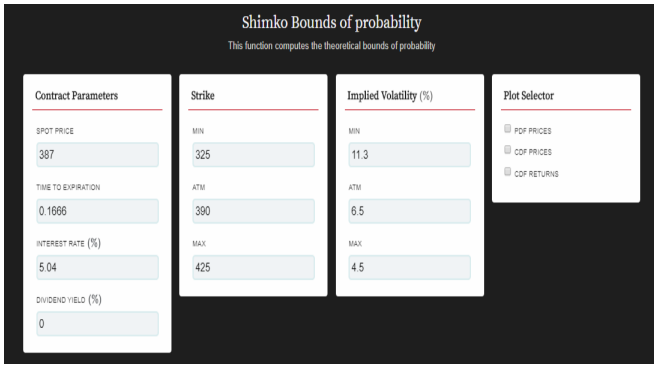

fig.1 Shimko Theorethical input form

Contract Parameters

- Spot Price: it’s the price of the Europen Option observed today on the market.
- Time to Expiration: the future date at which the option expire on annual basis.
- Divided Yield: the dividend yield paid by the index (annual continuosly coumpoded).
- Interest Rate: an appropriate risk free discount rate (annual continuously coumpoded).

Strike

- Strike MIN: is an arbitrary out the money strike (Strike MIN < Strike ATM).
- Strike ATM: is the strike at the money, closed to the spot price.
- Strike MAX: is an arbitrary in the money strike (Strike MAX > Strike ATM).

Implied Volatility

- Implied volatility MIN: is linked to Strike MIN choice.
- Implied volatility ATM: is linked to Strike ATM choice.
- Implied volatility MAX: is linked to Strike MAX choice.

Plot Selector

In the fourth group, Plot Selector, there is a choice for the user since the computation for all the graphs is quite slow.

- PDF prices: probability distribution plot of underlying asset prices
- CDF prices: cumulative distribution plot of underlying asset prices
- CDF returns: cumulative distribution plot of underlying asset returns

The probability distribution plot of index returns is computed by default everytime the user click on compute bottom.

The output

The procedure implemented in this section lead the user to two main results. The first one is a smiled implied volatility term structure represented by a parabola(fig.2). The second one is a series of graphs and numerical information related to the index probability distribution(fig.3-4-5). This distribution is built up on implied volatility term structure via Black and Scholes formula.

Smiled Implied Volatility Term Structure

Implied volatility profile is the first main result of the section Shimko Theoretical. The graph is a parabola where on x-axis we have strikes(k) and on y-axis smoothed implied volatility related to underlying asset of the European Option.

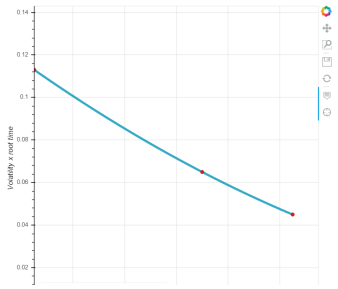

fig.2 Implied Volatility Profile

Referred to the above graph in the window 'Results' there are three parameters that characterize the shape of the implied volatility parabola (formula):

- a0: with higher(lower) a0 the parabola moves up so higher implied volatilies(lower implied volatilities).
- a1: positive(negative) a1 causes the parabola to move down and left(move up and right).
- a2: positive(negative) a2 causes the parabola to open upward(open downward)

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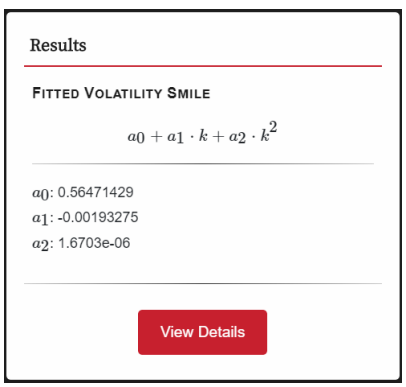

fig.3 Shimko Theoretical Results

Recovering index probability distribution from option prices

The volatilities in fig2 can be used to find smoothed call/put prices (BS) and the smoothed call prices can be differetiated to find the values of the density function and cumulative distribution for each possible index value at a certain maturity. For more details follow D. Shimko in (1993) "Bounds of probability Risk (Concord, NH), 6(4), 33–37". Below are shown the four plots results of the procedure.

- fig.1 log-returns : on the left(right) side the blue line is log-returns CDF(PDF) computed follown Shimko and the red line is the benchmark log-normal CDF(PDF).

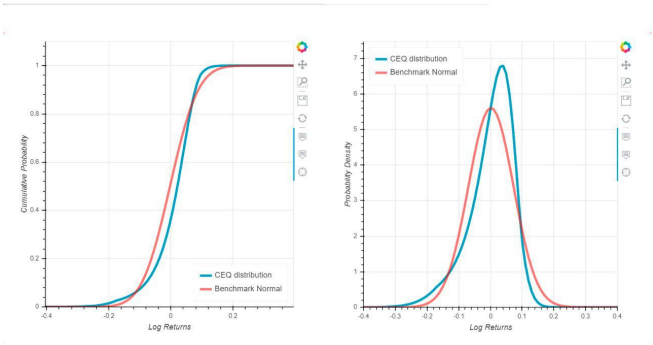

fig.4 Implied CEQ Returns Distribution/CDF

- fig.2 index values : on the left(right) side the blue line is index values PDF(CDF) computed follown Shimko and the red line is the benchmark normal PDF(CDF).

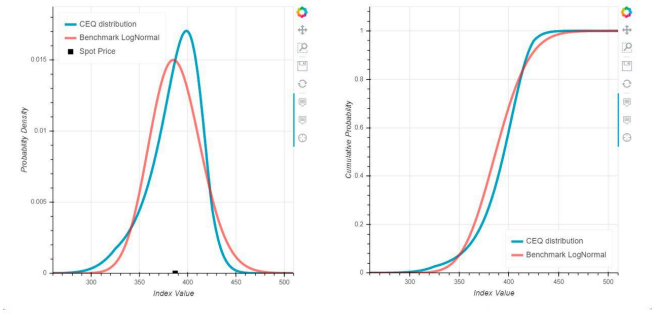

fig.5 Implied CEQ DIstribution/CDF

Table of moments

In the end there is the possibility for the user to click on view details (Fig.2 Shimko Theoretical Results), the output is a pop-up table containing the moments of each graph. In the example if we make a comparison between the benchmark logonormal and the implied index distribution we can say that the second one is negative skewed(negative slope implied volatility) and more leptokutic(implied volatiliy curve smile).

An additional feature is the bottom export table that stores the table in a new Excel file.

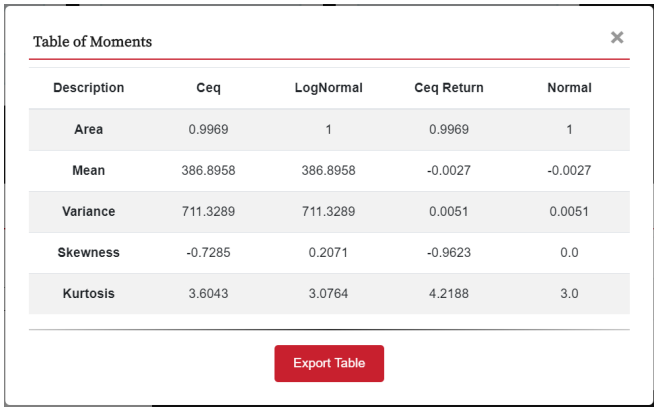

fig.6 Implied CEQ Returns Distribution/CDF

Chart Tools

In each chart there are interactive tools positioned at the top right. Here are listed all of them starting from the first one.

- ❏ Bokeh logo: hyperlink to access the bokeh site. Bokeh is the library that used to create all interactive graph in the web-application.
- ❏ Pan Tool: the pan tool allows the user to pan the plot by left-dragging a mouse or dragging a finger across the plot region.
- ❏ Box Zoom: the box zoom tool allows the user to define a rectangular region to zoom the plot bounds too, by left-dragging a mouse, or dragging a finger across the plot area.
- ❏ Save: the save tool pops up a modal dialog that allows the user to save a PNG image of the plot.
- ❏ Reset: The reset tool turns off all the selected tools.
- ❏ Hoover Tool: the hover tool will generate a "tabular" tooltip where each row contains a label, and its associated value.

References

David Shimko (1993), *Bounds of probability Risk*, Concord(NH).

`https://docs.bokeh.org/en/1.0.0/`

`https://webappfinance.pythonanywhere.com/`