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A Review on Implied Volatility Calculation

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Abstract

This paper aims to summarizing the different approaches in determining the implied volatility for the options. This value is of particular importance since it is the main component of the option's price and because, among traders, options are quoted in terms of volatility rather than price. After a discussion on the approximation methods, a numerical approach is explained. It is shown that, in order to ensure a fast and reliable convergence, the selection of an appropriate starting point is key. The authors' suggestion for choosing the first order approximation or the inflexion as initial point is also illustrated.

Keywords: Implied Volatility, Quantitative Methods, Numerical Calculus
JEL Classification: G10, C02, C88
2010 MSC: 65-02, 91G20, 91G60

Preface

For all goods as well as for the options, the main problem is to assign them a price. The classical Black & Scholes (1973) [3] formula, later extended by Merton, provides, within the Capital Asset Pricing Model(CAPM) framework, an elegant answer to the above problem by identifying a relation between the value of the stock and its option. This was not an easy task which required some "strong" assumptions (e.g. log-normal distribution, risk neutral valuation) and a formal link between the option and several factors such as time, underlying and volatility [15]. In particular, as the latter parameter was not directly observable, it raised some concerns about the practical suitability of the formula. In reality the Black & Scholes formula has been proven over the years to stand quite strong, and from that moment on, the problem to price an option has become to identify correctly the market volatility i.e. (once again) to find a price. As noted by Latané & Rendleman (1976) [21], the solution to this problem is given by extrapolation of the market volatility from the prices of the options, or otherwise from the 'observation' of the implied volatility. Due to the structure of the Black & Scholes formula, the implied volatility cannot be found in closed form but only through numerical approximation methods. Many articles have addressed the issue of trying to better approximate the "true" value of the volatility with more or less accurate results.

This paper is organized as follows: the first section gives an account of the literature on implied volatility, the second is about the most common closed form approximations (and the related limits), the third section illustrates numerical methods (such as the Newton-Raphson algorithm) which can return precise results in very few steps provided a "good" starting point is assigned. An explanation about the mathematical conditions needed for the algorithm to converge and on its efficiency (i.e. convergence in a very few steps) is given. Finally some examples are shown comparing numeric and approximation methods.