Book Review

OPTION PRICING MODELS & VOLATILITY USING EXCEL®-VBA

by Fabrice Douglas Rouah and Gregory Vainberg

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The introduction of higher moments of returns in the pricing of derivatives is the new breakthrough of financial engineering. It is a very complex subject, based on methods borrowed from sciences such as physics or advanced statistics. A well-known stylised fact of empirical finance is that the distribution of asset returns is usually not normal. Hence, taking into account higher moments is crucial, not only for the pricing of derivatives but also from the point of view of asset pricing theory, which must be rebuilt by incorporating higher moments. Higher moments also play a crucial role in empirical financial studies, such as those dealing with hedge fund performance, since returns of hedge funds are very leptokurtic. This book, written by Fabrice Rouah and Gregory Vainberg, is itself a breakthrough in finance because it is the only option pricing book that relates higher moments of returns, on the one hand, and the pricing of derivatives, on the other hand, and which treats this relationship entirely with VBA. The researcher and the practitioner now have a fascinating book with which to understand higher moments, derivatives pricing, and volatility. This book is filled with innovative VBA programs that are designed to compute prices of derivatives and volatilities. These

programs are exclusive to the book, and will prove to be essential for both academics and practitioners. A CD-ROM included with the book contains Excel files for implementing all the option pricing and volatility models covered. The structure of the VBA programs, whatever their degree of difficulty, is very clear and easy to understand, even for the neophyte in programming. As suggested by the title of the book, there is a close nontrivial relationship between option pricing models and volatility, the principal link being higher moments of returns. A quick survey of this book will reveal its usefulness for all serious researchers and practitioners in derivatives. The first chapters deal with mathematical methods currently used in the modern theory of derivatives. One chapter demystifies complex numbers, a tool often neglected by academics or practitioners in finance, perhaps because of the cabalistic nature of the imaginary unit ($\sqrt{-1}$), but which serves to compute characteristic functions used to estimate the risk-neutral probability distributions of returns, an essential input in the pricing of derivatives. Other tools considered by the authors are numerical integration, which is essential for many Monte Carlo simulations, and trees that incorporate higher moments, such as

that built upon an Edgeworth expansion. After describing these and other mathematical preliminaries, the authors present a chapter on the introduction of higher moments of returns in the Black and Scholes¹ model. Their VBA program on the pricing of options by the Gram–Charlier expansion is particularly interesting. It is useful not only for the pricing of traditional options, but also for the evaluation of credit derivatives, which are generally characterised by non-normal distributions. A main theme of the book is volatility, so the authors have dedicated an entire chapter to the Heston² model, which is very popular in financial research. Other chapters deal with the Heston and Nandi³ GARCH model. In these chapters, the authors show the impact of the correlation between the stochastic processes of the underlying of an option and of its volatility on the ‘volatility smile’. These two chapters also show how to use complex numbers in the pricing of derivatives. They set the foundation for three other chapters, which deal with implied volatility, model-free implied volatility and volatility returns. The chapter on model-free implied volatility is particularly interesting and up to date because it includes VBA programs of the latest theoretical approach to the computation of volatilities expectations. Dupire⁴ and Neuberger,⁵ Carr and Madan⁶ have shown that an expected payoff can be spanned by a continuum set of out-of-the-money calls and puts on the underlying spot across all strike prices. Variance being a squared payoff, for instance in variance swaps, it is equal to a strip of weighted out-of-the-money puts and calls, the weights being inversely proportional to the squared strikes of these options. Remarkably, returns variance can be defined in terms of a portfolio of options! The intuition behind this

relation is the straddle, a combination of a put and a call, which is a strategy that allows exposure to the future level of volatility. This result about the computation of volatility is another breakthrough of the modern finance and is fundamental to the computation of the VIX — the volatility index of the CBOE — and a reference for the pricing of volatility derivatives such as volatility swaps. Rouah and Vainberg are brilliant on the applications of this new concept of volatility. Their VBA program to compute the VIX is exclusive and will prove very useful to the financier. There exists very little material on the calibration of financial stochastic models. The book of Rouah and Vainberg fills this gap with brio. It contains VBA programs on loss functions that compute the parameters of stochastic models by minimising the spread between model and observed market prices. The algorithms used in these programs are explained in the first chapter of the book. Loss function estimation functions written in VBA were eagerly waited by quant analysts, and will be undoubtedly greeted with enthusiasm. There are other methods for calibrating stochastic models mentioned by the authors: the generalised method of moments (GMM), the efficient method of moments (EMM) and the simulated method of moments (SMM). But those methods might be found easily in popular software like E-views or S-plus. We could not leave this comment on the book of Rouah and Vainberg without mentioning other chapters dedicated to the computation of the Greeks, of the prices of exotic options and of model-free higher moments, higher moments being, as said before, the cornerstone of the book. These last chapters are written with great originality, clarity and a great sense of pedagogy, which is also the trademark of all the chapters of the book. Finally, this book abounds in

solved problems for students. It will thus be essential for a graduate or MBA course on derivatives or more generally, about financial engineering. Without doubt, the book of Rouah and Vainberg will quickly become a classic in all serious advanced finance academic programmes, especially in financial engineering.

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