

Report on the habilitation thesis

Integrated exponential of Brownian motion and related processes with applications to Asian option valuation

by Jan Vecer

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The habilitation thesis of Jan Vecer is a collection of six previously published papers. The methods and general theory is covered by an extensive 100+ pages introductory text. The papers cover a common topic, namely valuation of financial contracts whose payoff depend on the average price known as Asian options. This topic is important as it is related to the elementary statistics of the price, its average, and it has attracted attention from both academia and practice. The major obstacle in valuation of these contracts is the fact that the average price does not have an analytical distribution and one cannot obtain any closed form solutions for this problem. Historically, the early literature on the topics was mostly limited to simulation analysis or to complex semianalytical approaches that turned out to be impractical.

Jan Vecer has made the following contributions to this area of research. The modern pricing theory is based on a result called the First Fundamental Theorem of Asset Pricing that states that prices must follow a martingale evolution in order to prevent a possibility of producing a risk-free profit. Traditionally, this result was applied mostly only to dollar (or other currency) denominated prices. Later were these techniques extended to prices denominated in bonds in the context of valuation of interest rate products, indicating that the price can be understand in broader terms of a relationship of any two assets. Jan Vecer noted that the First Fundamental Theorem of Asset Pricing can be applied to any type of the price and developed a more general framework which allows to use a broader class of reference assets for pricing.

These techniques are well summarized in the introductory part of the habilitation thesis. The reference asset is also known as a numeraire and Jan Vecer wrote the entire monograph on this topic (Stochastic Finance: A Numeraire Approach, CRC Press 2011). An interesting application of the advantage of the general numeraire techniques is the situation of Asian options. The price of the contract that depend on the average is a 2 dimensional Markov process in the geometric Brownian motion model when the price is taken with respect to dollars, but only 1 dimensional Markov process when the price is

taken with respect to the stock. This is an interesting asymmetry which indicates that a better choice of the reference asset is the stock. The works of Jan Vecer showed in a great detail the path leading to a better understanding of the entire field of asset pricing.

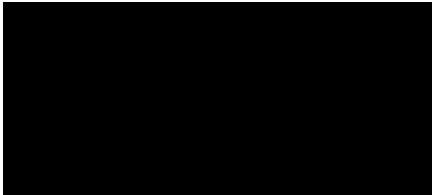
The papers in the habilitation thesis themselves appeared in top quality peer reviewed journals and there is no doubt about their merit. The journals "Mathematical Finance" and "Finance and Stochastics" are regarded as the very top journals in this field. A brief summary of these papers is the following. The first paper, "Options on a traded account: Vacation calls, vacation puts and passport options," coauthored with Steven Shreve, his PhD adviser, notes the advantage of a choice of a stock as a reference asset in the context of passport options. The following papers, "A new PDE approach for pricing arithmetic average Asian options," and "Unified Asian pricing," extend the idea of the stock used as a numeraire to pricing contracts that depend on the average in a traditional diffusion setup. The paper "Pricing Asian options in a semimartingale model" discusses more general models of the price martingale evolution that also include jumps. A very deep analysis is done in the paper "Black-Scholes representation for Asian options" that finds model free representation of the Asian options based on martingale measures generated by different reference asset. This mathematically very challenging paper shows for instance also representation of the replicating portfolio, giving robust bounds on asset positions of such a portfolio. The last paper, "Asian options on the harmonic average", shows that these techniques can be also applied in other types of price averaging, such as the harmonic average.

The contributions listed in the above works are significant for this field. Jan Vecer almost single-handedly developed pricing techniques that currently represent the mainstream approach in pricing such products. The price characterization given by his approach leads to a formulation based on partial differential equations (PDE) that can be solved numerically with arbitrary precision. The PDE methods are superior to any alternative approaches, such as simulation analysis or semianalytical approaches. In addition, the presented methods apply in situations of discrete averaging, where the alternative methods do not apply at all.

The papers of Jan Vecer have been cited more than 1000 times according to the google scholar database, ranking him as one of the internationally recognized figure in the field. He has been supported by research grants, in particular he won two prestigious grants awarded by National Science Foundation in the USA. He has been previously affiliated by the top academic institutions, such as Carnegie Mellon University (PhD study), University of Michigan, Kyoto University, Columbia University and the Frankfurt School of Finance and Management. Columbia University promoted him to the rank of Associate Professor in 2006 and he was promoted to a full Professor of finance in Germany before joining the Frankfurt School of Finance and Management. This itself means that his previous contributions were carefully checked in very rigorous promotion processes. He has supervised 6 PhD students, some of them are now themselves well established academics. Olympia Hadjiliadis is a full professor in the Department of Mathematics and Statistics in the City University of New York, Stephen Taylor is an assistant professor at the Martin Tuchman School of Management in the New Jersey Institute of

Technology and Libor Pospisil is a lecturer at the Department of Statistics at the University of California, Berkeley (his main affiliation is a director at the rating agency Moody's).

The author's work is recognized internationally. Moreover, he continues to produce new quality papers, which is a promising sign for achieving further prominence in this research area. In conclusion, the author has made important contributions to the asset pricing theory and I recommend the award of the habilitation for this work.



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