

Option markets : implied information, equity process and risk management

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Summary

Option markets and option implied information

Options and derivatives are powerful tools for market participants in order to manage risks or to speculate. The sizeable growth of derivative markets attests to the importance of options in the modern financial landscape. Although options are not a novel intellectual concept, the development of liquid option markets is recent. According to the Bank of International Settlement the Over-The-Counter derivatives total gross market value was marginally over \$2,500 billion in 1998. In 2013 this gross market value reached more than \$18,500 billion. This is an almost six fold increase in just fifteen years.

In addition to option traders and risk professionals, financial economists have a strong interest in option and derivative markets. This interest explains the development of many articles and dedicated journals on the topic. Options offer economists the opportunity to uncovering investors' expectations. The price of an option depends on its payoff and therefore on the expected distribution of the underlying asset (e.g. stock price, commodity price, interest rate, etc.). Accordingly, option prices contain information on investor's expectations. This valuable information is called '*option implied information*'.

In this dissertation I intend to investigate, under option implied information and option implied volatility from different angles. My findings summarised in the following paragraphs highlight the opportunities and limitations arising from option implied information and from the discrepancy between the *risk neutral* and *physical expectations*. Option prices reflect both the expectation and risk preference of option traders. Because of the second component the information extracted from option prices is risk adjusted and is different from the actual physical expectations.

Estimation of volatility model on option prices

Volatility and the volatility dynamics are paramount for option pricing. The significant amount of research carried out on time series volatility modelling generates important and significant knowledge on the features of financial markets volatility. Volatility models are traditionally estimated and evaluated on the underlying asset dynamics with standard, developed and well known likelihood techniques. The same parameter values can be used to price options. Nevertheless this approach assumes that the risk neutral expectation necessary

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to price options is identical to the physical expectation. Relying on physical volatility parameter values to price options comes at the cost of poor pricing performances. The divergence between risk neutral and physical volatility parameter values motivates option pricers to calibrate models directly on option prices. However the econometric frameworks available for estimating volatility models directly on option prices are less developed than their time series counterpart. Chapter two and three of this dissertation develop and enhance the methodologies related to model and data selection in this context.

In chapter two, I assess and study the effect of measurement, model and parameter uncertainty on option pricing model performance evaluation. Parameters estimated on option prices, resulting predicted prices and loss functions are only point estimates and are characterised by an entire probability distribution function. This dissertation provides a framework to obtain the loss function distribution instead of relying only on a single point estimates as commonly done in practice and industry. The measured estimation uncertainty and uncertainty around option pricing models' loss function is large. Furthermore, I find that over fitting is a concern for models calibrated on a single cross-section of options. Cross-sections of options display wide heterogeneity both in term of pricing performance and estimation uncertainty. This heterogeneity has to be accounted for when continuous recalibration is used.

In chapter three, I focus on option data selection and answer the question: What is the impact of data selection on model-predicted option prices? Alternative and divergent data selection methods are presented in the literature and in practice. I demonstrate that parameter estimates and predicted prices are largely affected by the data used for estimation purposes. Filtered data and the loss function interact and provide a higher implicit weight to certain options. The option prices excluded from the calibration sample are not well captured by the resulting parameter estimates. We show that in addition to model selection and loss function selection, data selection should be regarded as a key determinant of option predicted prices.

Implied volatility and realized volatility

In the second part of the dissertation, I focus on the difference between options implied volatility and realized volatility. The risk neutral volatility expectation surpasses the physical volatility expectation because of the volatility risk premium. For example, since 2002, the VIX is more than 3.5% higher than the S&P 500 volatility. Investors pay a premium to hedge against an undesirable change in spot volatility. In chapter four and five, the dissertation highlights that the discrepancy between implied and realized volatilities is beneficial in the case of asset pricing but is impairing in the context of risk management.

In chapter four the dissertation studies the expected returns of the cross-section of stocks in the US market. We find that option implied information helps to explain the dispersion in expected return across stocks. More precisely, the difference between realized and implied

volatilities is a priced factor on the equity market. Stocks which co-move with the volatility risk premium are compensated with higher expected returns. In this context, the spread between implied and realized volatilities is a valuable source of information to indicate the state of the world for equity investors. On the one hand, equity index option implied volatility is relevant for the cross-section of the entire universe of stocks. On the other hand, oil implied volatility is only relevant within oil related industries. Our finding supports the theory of market segmentation and investors' limited attention.

In chapter five, the dissertation assesses the risk management application of implied volatility. We study, evaluate and compare the performance of implied volatility based Value-at-Risk (VaR) measures for three major equity indices over a period of up to twenty-four years. Our results demonstrate that the volatility risk premium embedded in option prices causes implied volatility VaR to be downwardly biased. In an attempt to correct for this impeding factor we provide a parametric and a non-parametric volatility risk premium adjusted implied volatility VaR. The adjusted risk measures correct efficiently the implied volatility VaR bias. But they do not outperform a standard time series VaR such as the GJR Garch VaR. We conclude that unless more sophisticated volatility risk premium adjustments are developed, option implied volatility has limited value when predicting VaR.