Project Summary

The purpose of this project is to bridge two important strands of the literature in Finance, hitherto relatively unexplored; one pertains to the objective or physical measure used to model the underlying asset and the other to the risk-neutral measure used to price derivatives. However, building a bridge between the objective and risk-neutral measures raises several important issues which need to be addressed first. In addition, it also opens up possibilities for comparing the information in the underlying fundamental and options data, a theme which has been the subject of some research in the past. Our goal for the project is [i] to learn more about the informational content of option prices; and [ii] to know how to improve the statistical precision of diffusion parameters by incorporating options.

We propose to investigate the above questions in a unifying framework, by using a stochastic volatility model with jumps (SVJ). The estimation and appraisal of the model take place by exploiting a joint distribution of fundamentals and options. Specifically, we propose a generic procedure for estimating and pricing options using simultaneously the fundamental price, and a set of option contracts involving the Black-Scholes implied volatility. In principle, we manage a panel of options, i.e. a time series of cross-sections. We note that our analysis is not limited to any particular model. The choice of the SVJ model is particularly convenient because [i] it has closed-form option pricing formula, which represents a considerable computational advantage; and [ii] because the SVJ model has received much attention in the literature, which makes our analysis comparable with results previously reported. In addition, Finance theory also suggests that, for stochastic volatility models with two state variables, we should consider the fundamental and its derivative contracts jointly to estimate diffusion parameters and price options simultaneously. Thus there are compelling theoretical reasons to pursue this approach, as in a stochastic volatility economy options must be added to create a complete market model. The complete market model guarantees the existence and uniqueness of the risk-neutral probability density used to price the option contracts. If done judiciously, the proposed approach should dominate the existing approach of using either options or fundamental.

The procedure we plan to use in this project is efficient method of moments (EMM), extended to incorporate option prices and fundamentals simultaneously. We show that the EMM procedure, which is a simulation-based estimation technique, allows us to estimate the model parameters under both the objective and risk-neutral probability measures by using simultaneously implied volatilities and the underlying asset data. Indeed, time series of the underlying asset provide parameters under the objective probability measure while risk-neutral parameters can be retrieved from options. Since the model we adopt has a closed-form option pricing formula, we can obtain the volatilities implied by the Black-Scholes formula from the simulated data and contrast them with their counterparts from the real data via the EMM framework. This procedure yields parameter estimates under the risk-neutral measure. Having estimated the risk-neutral and objective measures separately allows us to appraise the typical risk-neutral representations used in the literature. In particular, in order to obtain closed-form solutions, the standard approach assumes that the linearity of the volatility drift is preserved. We are able to determine if this assumption is consistent with the data.

Budget requested for 1 PhD student (Shan Chen)