A Dissertation Defense for **Natalia Beliaeva**, Ph.D. Candidate in Finance, has been scheduled for Tuesday, August 29, 2006 at 2:00pm in SOM 112. All are invited to attend

Committee Chair: Sanjay Nawalka

Title: Efficient Lattice Methods for Pricing Contingent Claims Under Stochastic Volatility and Jumps Models

Abstract:

This dissertation develops efficient lattice methods for pricing American options under stochastic volatility models, and stochastic volatility models extended with jumps in asset returns. It is also develops the framework for building lattices for stochastic volatility models extended with jumps in both asset returns and volatility. The lattice methods are developed using new theoretical results for the development of recombining lattices, including a correction to the square root transform of Nelson and Ramaswamy [1990]. These lattice models allow pricing of American options under the stochastic volatility/jump models of Bakshi, Cao, and Chen [1997], Pan [2002], Duffie, Pan, and Singleton [2000], and others. The parameters of various models are estimated using the market data on European options on S&P 100 index. The performance of four different models is assessed by using obtained parameters to price American options on S&P 100 index.

The first chapter demonstrates how to build a recombining tree for the square root processes, such as the CIR model or the volatility process in Heston [1993]. Nelson and Ramaswamy [1990] develop a transform to generate recombining trees for the square root process. The original transform by Nelson and Ramaswamy contains an error for the case when the short rate hits the zero boundary, which results in significant overestimation of the bond prices. This chapter corrects this error and develops a more efficient truncated tree for the square root process. Similar transforms are also derived for all short rate Markovian models given in Chan, Karolyi, Longstaff, and Saunders [1992].

The second chapter develops a two-dimensional orthogonal transform that allows the construction of two-factor trinomial trees for stochastic volatility models of Hull and White [1987], Wiggins [1987], Chesney and Scott [1989], Stein and Stein [1991], Heston [1993], and others. The transform creates a new process which is conditionally independent of the volatility process. The conditional independence plays a useful role in developing recombining lattices for all stochastic volatility models. The results are demonstrated using the examples of Hull and White [1987] and Heston [1993] models.

The lattice based on the two-dimensional transform and the truncated tree for the volatility process, outperforms both the LBA approach of Guan and Xiaoqiang [2001] and the lattice procedure developed by Leisen [2000], in terms of the efficiency/accuracy trade-off. As another application, the orthogonal transform is also applied to build a lattice for the two factor maximal A1(2) model of the short rate given by Dai and Singleton [2000].

The third chapter shows how to build a jump-diffusion recombining lattice for the stochastic volatility model of Heston [1993] extended with jumps in asset returns. This lattice is used to price American options under the SVJ models developed by Bates [1996], Bakshi, Cao, and Chen [1997] and Pan [2002]. The results from the lattice show high accuracy in pricing European options. This chapter also lays down the foundation for building jump-diffusion recombining lattices for the models of Duffie, Pan, and Singleton (DPS) [2000], and Eraker, Johannes and Polson (EJP) [2003]. These models allow jumps in both asset returns and volatility. The theory is developed for two cases, as follows,

i) jumps between asset returns and volatility process are perfectly correlated, and
ii) jumps between asset returns and volatility process are partially correlated.

The contribution of the third chapter is especially significant given no recombining lattice approaches have been developed in the literature to simultaneously account for both stochastic volatility and jumps.

As a final contribution, the forth chapter estimates the parameters of four different models using cross-section of market data on European options on S&P 100 index. Four models considered here are constant volatility model of Black Scholes, stochastic volatility model of Heston [1993], stochastic volatility model extended with jumps in asset returns of Bates [1996], and Bakshi, Cao, and Chen [1997] and stochastic volatility model extended with jumps in asset returns of Pan [2002]. The performance of four models is assessed by applying developed lattice procedures to price American options on S&P 100 index using parameters estimated using European options.