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A BSDE Approach to Convex Risk Measures for Derivative Securities

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Abstract: A backward stochastic differential equation, (BSDE), approach is used to evaluate convex risk measures for unhedged positions of derivative securities in a continuous-time economy. Backward stochastic differential equations provide a natural and theoretically sound approach to value convex risk measures for derivative securities. A two-stage procedure is used. Initially, a pricing BSDE is used to value a derivative position. Then, at the second stage, a family of real-world probabilities is used to evaluate the unhedged risk of the derivative position, which is formulated as a stochastic control problem. The convex risk measure is represented as the solution of a BSDE.

We use the Clark-Ocone representation result together with Malliavin calculus to identify the integrand in the martingale representation associated with the BSDE. This, in turn, involves the Malliavin derivative of the solution of the pricing BSDE. In the Markov case, we relate the BSDE solution to a partial differential equation solution for convex risk measure evaluation via a nonlinear Feynman-Kac formula.