University of Zurich[UZH]

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Pricing and Hedging of Commodity Options under SABR model

Jan Cuonz

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Prof. Dr. Marc Chesney

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Abstract

In this paper, we develop the commodity-SABR (c-SABR) model, a new stochastic volatility model which accounts for the characteristics of non-seasonal commodities such as copper, gold, silver or WTI crude oil. The c-SABR model bases on the original SABR model but additionally includes a volatility mean reversion component and a time-dependent volatility dampening term which allow to efficiently capture the dynamics of a wide range of commodities. We derive the pricing partial differential equation for the c-SABR model and state the system of inequalities that has to be solved in order to obtain the price of an American options contract. Using the continuous Galerkin finite element method, we discretize in space and give the variational formulation which we reformulate using Lagrangian multipliers. After discretizing in time, the resulting sequence of linear complementary problems is solved by the semismooth Newton algorithm. Based on actual option market data, the model is calibrated using a least squares procedure for nonlinear problems. The finite element method allows us to price options for all strikes and maturities in one run. We calculate the value surface as well as the free boundary. In order to validate the model, an error analysis is conducted and we find that the c-SABR model is suited very well for pricing options on non-seasonal commodities like copper, gold, silver or WTI crude oil. Especially compared to the standard SABR model, we are able to achieve a remarkably better fit to market data. Finally, different sensitivities of our solution to the American option pricing problem are numerically calculated, again utilizing the finite element framework.