

A McKean-Vlasov game of commodity production, consumption and trading

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Abstract

We propose a model where a producer and a consumer can affect the price dynamics of some commodity controlling drift and volatility of, respectively, the production rate and the consumption rate. We assume that the producer has a short position in a forward contract on λ units of the underlying at a fixed price F , while the consumer has the corresponding long position. Moreover, both players are risk-averse with respect to their financial position and their risk aversions are modelled through an integrated-variance penalization. We study the impact of risk aversion on the interaction between the producer and the consumer as well as on the derivative price. In mathematical terms, we are dealing with a two-player linear-quadratic McKean–Vlasov stochastic differential game. Using methods based on the martingale optimality principle and BSDEs, we find a Nash equilibrium and characterize the corresponding strategies and payoffs in semi-explicit form. Furthermore, we compute the two indifference prices (one for the producer and one for the consumer) induced by that equilibrium and we determine the quantity λ such that the players agree on the price. Finally, we illustrate our results with some numerics. In particular, we focus on how the risk aversions and the volatility control costs of the players affect the derivative price.

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