Hedging for the Downside Risk:
Integrated Production Planning and Risk Hedging with CVaR Objective

by

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Abstract:

We study the integrated production planning and risk hedging problem for a single production cycle, with the stochastic demand impacted by certain financial asset prices. We work with a demand model that does not assume specific functional forms for the linkage with assets and thus readily accommodates data analytics that are specific to application context. Besides production quantity decision made at the beginning of the planning horizon, a dynamic hedging strategy to be carried out throughout the horizon using the assets is motivated. The hedging strategy is constrained by partial information and a cap on loss over its profit/loss path. The production and hedging policies are jointly optimized to manage downside risk --- the expected total wealth over certain worst quantiles is to be maximized, and this leads to a Conditional Value at Risk (CVaR) objective. By using the convex representation of CVaR, we decompose the problem into a dynamic hedging problem and a static production problem. The hedging problem takes the form of minimizing a shortfall --- the gap of total wealth below certain target level, and we derive the optimal hedging in closed-form by developing a static lower bound problem. Interestingly, the optimal hedging takes form of a portfolio comprising a digital option and a put option. Then, the production problem is shown to be a deterministic convex problem over the production quantity and a target level. The optimal production quantity is analytically characterized and shown to be greater than the production-only optimal quantity. Furthermore, we fully characterize the relationship between the downside risk aversion and the optimal CVaR, and quantify the improvement in CVaR over production-only policy.

Bio:

Liao Wang is an assistant professor at the Faculty of Business and Economics of The University of Hong Kong. Her research interest lies in integrated financial and operational risk management, financial engineering and finance/innovation interface. Her work has been published in Operations Research and Production and Operations Management. She received a PhD degree in Operations Research from Columbia University, an MEng degree from Cornell University and a bachelor's degree in quantitative finance from National University of Singapore.

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All are welcome!