64d Integrating Finance and Control for Process Operations

Jeffrey C. Kantor

This paper considers prospects for an integrated approach to the finance and control of processes producing commodity goods. Financial markets offer producers opportunities to reduce short term exposure to many market uncertainties. To Hedgers take positions in financial instruments, such as futures and options, that offset the impact of market volatility. In particular industries, such as electricity generation and commodity agriculture, the practice is so well refined that producers value and operate their production assets as if they were financial instruments. The return to the producer is the net result of integrated financial and process operations. The goal of this paper is to describe general principles underlying these practices, and to consider and compare analytical approaches.

Why hedge process operations? In spite of the wide spread use of hedging1, riskiness, by itself, is not a sufficient reason to hedge process operations. In a frictionless capital market, the Capital Asset Pricing Model (CAPM) and the ModiglianiMiller theory suggest that large, publicly held firms gain no value from hedging designed solely to reduce riskiness. This is because shareholders can eliminate diversifiable risk by managing a portfolio of investments, thus there is no additional value to the investors for the firm to hedge diversifiable risk. Similarly, shareholders can allocate wealth between riskless assets and the market (the ‘two-fund' theorem), so again they receive no additional value from a public firm hedging solely to reduce market risk.

Recent empirical work [13, 4], supported by theoretical models [23, 7, 2, 11, 22, 9, 19, 5] shows firms, due to market inefficiencies and frictions hedge, hedge in order to: (1) avoid financial distress, (2) minimize the impact of tax convexities, (3) reduce the need for outside capital, and (4) maintain a more stable cash flow with which to pursue other value generating opportunities. Further, investors whose wealth cannot be diversified are typically riskadverse. Taken together, these reasons suggest that value can be returned to investors from operations by reducing cash flow volatility.

Consistent with CAPM and other capital pricing models, the objective of the integrated control of finance and process operations is to operate at the ‘efficient frontier,' that is to minimize cash flow volatility for a given expected rate of return. Conceptually, we seek methods to dynamically control a process and an associated hedge portfolio in response to market and process observations. The goal is to maximize an objective function that includes a weighted measure of expected return and cash flow volatility.

Relevant prior work includes Anderson and Danthine's [1, 21] consideration over a single period of the production of multiple cash goods subject to price uncertainty. By introducing a hedge against correlated futures contracts, they found a optimal hedge position and production levels. Empirical application to a cattle feeding operation [20] demonstrated enhanced return and reduced variance compared to traditional hedging strategies and the existence of an ‘efficient frontier' of operation. In a major paper, Brennan and Schwartz [3], constructed a dynamic hedge for a hypothetical mining operation and coupled control strategy that provided for mine startup, shutdown, and abandonment based on observed price signals. A far reaching result of this approach was to establish a 'real option' value for the optimally operated process. Other relevant work includes [22, 14, 10, 6, 15]. In particular, a recent theoretical problem demonstrates application of these ideas to inventory management [12].

This work is closely related to the rapidly growing literature on socalled 'Real Options'. In particular, establishing risk minimizing hedge portfolios and stochastic dynamic programming are key methods. The Real Options literature, unfortunately, is remarkably lax in discriminating among sources of diversifiable and idiosyncratic risks, describing decision processes, and in the application of the socalled

Marketable Asset Disclaimer (MAD) [8]. For the applications envisaged here, the resulting cashflow streams are not likely to be in the span of cash streams produced by marketable commodity derivatives. Thus Luenberger's work on pricing [17, 18] for incomplete markets is an essential element of this work.

Also of direct relevance to this work are computational techniques for larger scale and approximate stochastic dynamic programming [16] including the more recent work by Tsitsiklis and Van Roy, and Jay Lee.

To fix ideas, the paper will consider the valuation of a novel ‘Ethanol Crack Spread.' Preliminary work has demonstrated an alternative commodity spread for Ethanol based on weighted sum of CBOT Ethanol, Corn, Gas, and Soybean futures. The spread is a mean-reverting subject to significant volatility. The consequences for ethanol process operation, management, and valuation will be discussed.

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1) In a 1990 survey of the 372 non-financial firms among the Fortune 500, Geczy. et al. [13], found 59.1% of all firms used financial derivatives of some form. That fraction increased to 68.8% among energy producers, and to 75% in petroleum refining.

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