Merchant Operations of Commodity and Energy Conversion Assets Using Approximate Dynamic Programming

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My thesis studies the merchant operations of commodity and energy conversion assets. Examples of such assets include natural gas pipelines and storage facilities, commodity swing options, oil refineries, and power plants. Merchant operations involves managing these assets as real options on commodity and energy prices with the objective of maximizing the market values of these assets.

The economic relevance of natural gas conversion assets has increased considerably since the occurrence of the oil and gas shale boom; for example, the Energy Information Agency expects natural gas to be the source of 30% of the world's electricity production by 2040 and the Interstate Natural Gas Association of America projects United States infrastructure spending on natural gas pipeline systems to be 100-170 Billion dollars between 2008 and 2030.

Managing commodity and energy conversion assets gives rise to intractable Markov decision problems (MDPs), especially when using high dimensional price models commonly employed in practice. My thesis develops new approximate dynamic programming (ADP) methods to compute near optimal operating policies for these MDPs and estimate lower and upper bounds on the values of optimal policies for these MDPs. My thesis also applies these methods to existing and novel application settings.

In my proposal, I will discuss completed and future work that deals with (i) A linear programming relaxation ADP methodology applied in the context of the merchant management of commodity storage assets; (ii) A least squares Monte Carlo ADP method illustrated on commodity storage and swing option assets; (iii) An application concerning the joint merchant management of natural gas storage and transport assets; and (iv) Connections among different ADP methods suitable for managing general commodity and energy conversion assets.

Although the ADP methods developed in my thesis are applied to manage commodity and energy conversion assets, these methods have potential broader relevance for solving stochastic optimization problems arising in financial and real option valuation, health care management, and supply chain management.