Senior Design Report

Matthew Kindy II, Aurea Li, & Dillan Prince

October 20, 2015

Contents

1 Summary

2 Introduction

One of the ways that BP makes money is by trading various commodities. For the scope of this project, the commodity that we are interested in is natural gas. A forward contract [1] is an agreement to buy or sell an asset at a certain future time for a certain price. Future contracts are forward contracts that are traded on the exchange, which provides a mechanism that gives the two parties a guarantee that the contract will be honored. Futures are used as a hedging tool for BP; as the price of natural gas is constantly changing, BP buys and sells future contracts in order to lock down costs and revenues for natural gas. The process of trading natural gas can be simplified down to the following: BP buys a forward contract (and thus receives natural gas) at a specified price. The natural gas is then delivered to BP and stored in one of their warehouses at the time the forward contract is exercised. Then, BP sells a forward contract and delivers the natural gas to the buyer. By choosing appropriate prices for buying and selling forward contracts in natural gas, BP can make profits off of receiving and delivering this commodity. However, future prices change on a daily basis and behave somewhat unpredictably. Moreover, BP has to factor in cost of transporting the gas as well as storing it. We are interested in building an optimization model that tell BP what forward contracts to buy and sell in order to maximize revenue from trading natural gas.

3 Literature Review

4 Problem Statement

5 Model

Variable definitions:

g: constant conversion from contracts to mmbtu per day

d_k: forward contracts delivered during month k

e_k: forward contracts exercised during month k

f_k: forward curve for month k

q_k: cost of withdrawal for month k

p_k: cost of injection for month k

i_k: maximum injection rate for month k

w_k: maximum withdrawal rate for month k

l_k: Minimum inventory required at the end of month k

$v_{k,j}$: Volume on day j of month k

Objective function:

$$\begin{aligned} &\texttt{maximize (revenue - cost)} \\ &= \max\{d^T f - g d^T q - e^T f - g e^T p\} \\ &= \max\{d^T (f - gq) - e^T (f + gp)\} \\ &= \max \begin{pmatrix} f - gq \\ -f - gp \end{pmatrix}^T \begin{pmatrix} d \\ e \end{pmatrix} \\ &= \max c^T x \end{aligned}$$

Constraints: Let s be the total number of days that have passed since January

1.

- Inventory minimum: $l_k \leq v_s$ for $k = 1, 2, \ldots, 12$.
- Maximum injection: $v_{s+1} - v_s \leq i(v_s)$ for $s = 1, 2, \ldots$.
- Minimum injection: $v_s - v_{s+1} \leq w(v_s)$ for $s = 1, 2, \ldots$.
- Starting volume: $v_0 = V_0$.
- End volume: $v_{365(?)} = V_n$.

6 Methods

7 Results

8 Future Work

References

[1] boyd, d., and Ellison, N. "Social Network Sites: Definition, History, and Scholarship." *Journal of Computer-Mediated Communication* 13, no. 1 (2007): 210-30.