Real Options in Energy:

Pricing, Hedging and Trading

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VALUATION CASES

Why do commodities have option value?

- Option to change the form of a commodity is called:

Crude oil --> Gasoline + jet fuel
Beef <--- Live cattle + grain & feed
Steel + Nickel --> Stainless steel

Refining, conversion, etc.

- Option to change the place of a commodity is called:

Transport option - exercise if net transport costs are less than increased price

- Option to change the time of a commodity's use is called:

Storage option

- Many commodities have all three options present.

Contents

1. Crack spread option (trades on NYMEX)
2. Simplified petroleum refinery (or gas-fired power plant)
3. Gas storage
4. Pipeline capacity

Implementation in Excel (corrected)

- z_1 = normsinv(rand()); z_2 = normsinv(rand())
- $z_3 = \rho z_1 + z_2\sqrt{1-\rho^2}$ (now z_1 and z_3 are appropriately correlated normal numbers)
- r = risk-free rate

When using futures, set this value equal to zero

- Crude oil simulated price at expiration $C = F_C e^{\left(0-\frac{1}{2}\sigma_C^2\right)T+z_1\sigma_C\sqrt{T}}$
- Heating oil simulated price at expiration $H = F_H e^{\left(0-\frac{1}{2}\sigma_H^2\right)T+z_3\sigma_H\sqrt{T}}$
- Present value of option payoff = $e^{-rT}Max(42H-C-X,0)$

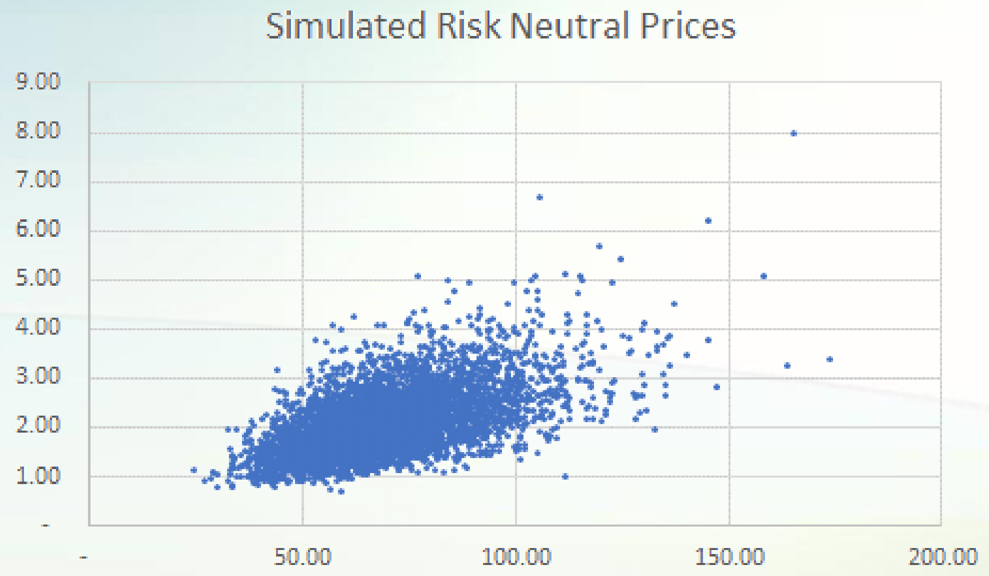
crack spread option (CSO)

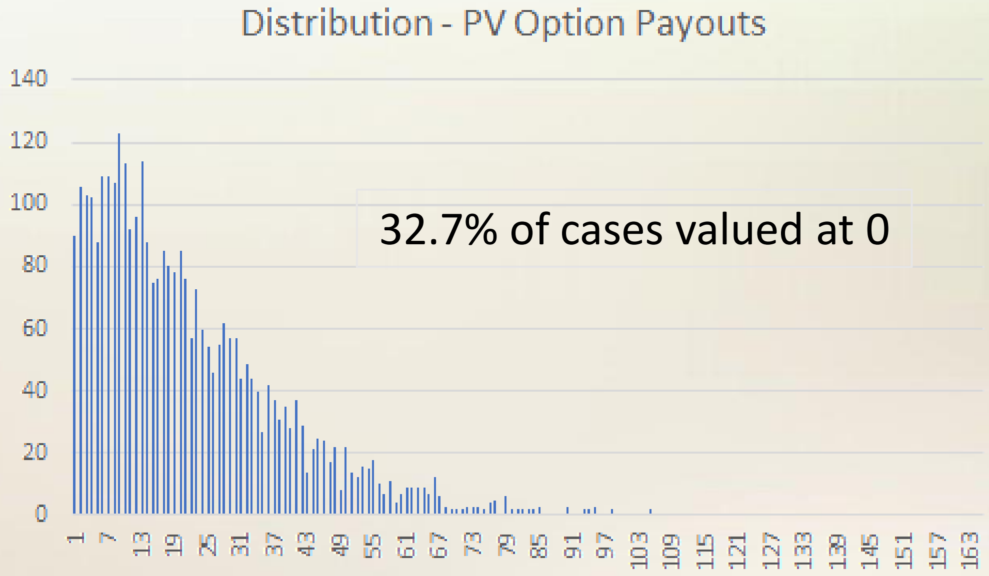
- Simulate and average until the maximum error is acceptably small
  - Max error = 2 x stdev(simulations)/sqrt(number of simulations)

Net revenue to refinery is an option-like payout --- if crack spread exceeds strike, then produce; if lower then not.

Process steps

- Use fixed random numbers
- Convert uncorrelated z values to correlated values
- Compute future price simulations for WTI and HTO
- Compute PV of option payout
- Average and determine max error





Results

- Estimated option value is $\$14.52 \pm 0.51$
- Reduce error by increasing number of simulations
- Revaluations show how option price revalues with WTI and HTO
- Deltas show how the option prices change relative to the base case for hedging purposes

Average option value			14.52
Max error			0.51

Revaluations

14.52	2.12	2.13	2.14
67.5	14.86	15.18	15.49
68.5	14.21	14.52	14.83
69.5	13.58	13.88	14.18

Deltas	2.12	2.13	2.14
67.5	0.34	0.66	0.97
68.5	(0.31)	-	0.31
69.5	(0.94)	(0.64)	(0.34)

Consider an oil refinery

- What options are present?
  - Option to shut down or slow down production when unprofitable
  - Option to store oil or products
  - Options to change the refining slate, or the combination of oil products (gasoline, heating oil, jet fuel, etc.) refined
  - Options to change the input fuel (different grades, API weights, sulfur contents)
  - Option to source from and deliver to different locations
- Do you think we can use the BSM model to value a refinery?

Real options example valuation

	Spot price	LR Mean	Speed/mo	Vol/mo	Correlation
Products	\$58	\$60	7%	5%	60%
Crude	\$50	\$55	5%	4%	

- Cost of refining = \$5/bbl variable plus \$50,000 fixed per month
- Refinery capacity = 300,000 bbl/mo
- Tax rate 35%
- Crack spread futures \$7.50 all months

- PROBLEM:
- Build a pro-forma for 12 months of operation
- Value the option to close the refinery assuming the decision is made monthly as the next month's price is known (using 100 sims)
- Benchmark to CS futures
- Risk-free rate is 2%
- Construct economic balance sheet

Simplified refinery: Monthly on/off based on profitability

Benchmark cash flows to crack spread

- Simulate cash flows
- Regress on crack spread futures to determine replicating portfolio
- Discount at the risk-free rate

Simulation steps: Prices and Net Income

- Simulate oil and product prices
- Fixed random numbers are chosen by case number 1-100
- Develop proforma with and without option to close

VALUATION OF A SIMPLE REFINERY (one year lease)

CASE ANALYSIS

	Case number			15 of 100					
			Month						
		0	1	2	3	4	5	6	
UNIFORM	Rand Oil		0.71	0.98	0.86	0.91	0.54	0.99	
Uncorrelated	Rand Products		0.31	0.51	0.98	0.03	0.50	0.75	
NORMAL	Rand Oil		0.56	1.97	1.09	1.31	0.10	2.38	
Correlated	Rand Products		-0.06	1.19	2.27	-0.73	0.07	1.96	
	Oil	50.00	51.37	55.59	57.98	60.88	60.82	66.31	
	Products	58.00	57.98	61.58	68.47	65.37	65.21	71.25	
	Revenue (with var cost)		1,083,023	897,374	2,244,464	447,118	417,713	582,689	
	Fixed cost		50,000	50,000	50,000	50,000	50,000	50,000	
	EBITDA		1,033,023	847,374	2,194,464	397,118	367,713	532,689	
	Taxes		361,558	296,581	768,062	138,991	128,700	186,441	
	NET INCOME		671,465	550,793	1,426,401	258,127	239,014	346,248	

Income statement with or without the option

Value of shutdown option = Value of refinery with the option - value of refinery without option

Replication steps

- Tabulate 100 case results for net income and the crack spread using What-if table in Excel
- Regress Net Income on the CS crack spread
- Check R2 values for goodness of fit
- Find overall value by discounting at the risk-free rate

NI = a + b CS Futures
PV = ae-rt + b Spread*e-rt

DECOMPOSITION of Cash Flows via Regression	Months					
	1	2	3	4	5	6
Slope	192,183	181,541	177,702	161,359	171,117	168,101
Intercept	-593,972	-494,148	-453,843	-290,838	-379,217	-331,759
RSQ	99.83%	98.23%	96.92%	94.60%	95.38%	95.19%
CS futures	7.50	7.50	7.50	7.50	7.50	7.50
NI (average)	852,104	875,602	881,655	893,997	914,081	988,351
COMBINED VALUE	846,002	864,554	874,581	913,304	896,729	919,845

Valuation results

- Value = (a+b(CS futures))e^{-rt}
- The lease is estimated to be worth $10.5 mm
- The government's take is $6.2 mm
- Total asset value with option is $16.8 mm
- Incremental option value is $1.4 mm

Base Case balance sheet

ASSETS	Refinery without opti	15,433,812
	Option value	1,348,544
	Total assets	16,782,356
LIABILITIES	EQUITY	10,532,811
	GOVERNMENT	6,249,546
	Total liabilities	16,782,356

Extension: Benchmark to CSOs!

- CSO = Crack spread option
- E.g. CSO_T = Max(Products – Crude – variable cost, 0)
- Since we know the current market pricing of the CSO, we can proceed in another fashion
- $NI_T = a + b\ CSO_T$
- Value at time 0 = $ae^{-rT} + b\ CSO_0$

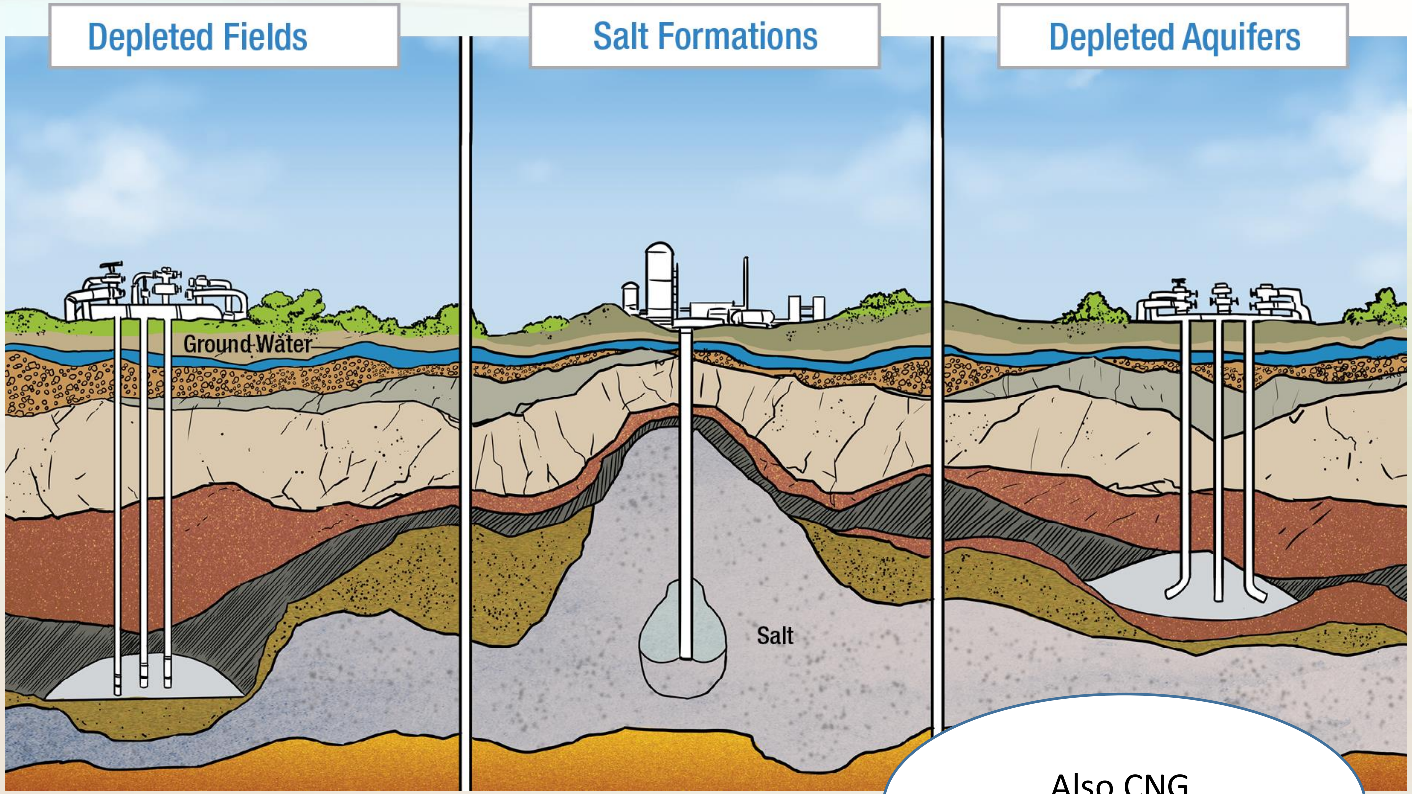
Gas storage operating characteristics

- Base and working gas capacities
  - Base gas = “Cushion gas”, never removed
  - Working gas = Deliverable
- Deliverability
  - Rate of release of gas from reserves
  - Highest when reservoir is close to maximum capacity
- Injection capacity
  - Rate of pumping into storage
  - Lowest when reservoir close to max
- Cycling
  - Number of times gas can be injected and withdrawn per year
  - Most in the U.S. are currently single cycle
    - Refilled Apr-Oct, Withdrawn Nov-Mar
    - Cannot serve summer peaking gas requirements
    - HDMC = High delivery multiple cycle

This is not cushion gas.

Types of gas storage facilities

- Depleted oil and gas reservoirs
  - Lowest delivery and injection rates, typically single cycle
  - Typically high base gas levels
  - Most U.S. capacity in these reservoirs in the Northeast
- Salt cavern storage
  - Low base requirements
  - Highest delivery and injection rates
  - High cycling --- 4-5 times/yr
  - Concentrated in Gulf Coast
- Aquifer storage
  - Defn: a body of permeable rock that can contain or transmit groundwater
  - High base requirements (~80%)
  - Otherwise lie between depleted reservoirs and salt caverns



Also CNG,
LNG and pipelines

Compressed nat gas,
liquefied nat gas

Natural gas price behavior

Storage = perpetual option to buy & sell gas within constraints

What should the injection/withdrawal strategy be?
Where does the value of gas storage come from?

Gas storage as a real option

- Options to inject
  - Subject to capacity limits
- Options to withdraw
  - Subject to gas availability
- Optimization of storage deployment
  - Control decisions
- What is storage?
  - Time-shifting of consumption
  - Option on the spot-futures basis

Discussion questions

- Is the ability to inject a put option?
- Is the ability to withdraw a call option?
- Where does the option value come from?
- Example:
  - What is the value of this strategy
    - Long 100 futures at 2.40
    - Short 100 futures at 2.60
  - Similar to injecting gas at 2.40 and withdrawing at 2.60 but less costly
- Where is the premium for the option being paid?

Option pricing approaches

- Monte Carlo simulation
  - Most flexible
  - Questions about how to handle optimization aspect
- Binomial-trinomial trees
  - May not be applicable for realistic problems
  - Often require solution of hyperbolic PDEs --- not just parabolic
  - Limited price behavior assumptions, e.g. no jumps
    - Jumps modeled by Poisson processes
- Numerical partial differential equations (PDE)
  - PIDE = Nonlinear partial-integro equations
  - See Thompson, Davidson and Rasmussen
    - "Natural Gas Storage Valuation and Optimization: A Real Options Approach"

Some notation and the optimization objective

Notation

P = spot price of natural gas under the risk-neutral measure

I = current amount of gas inventory

c = amount being released (c>0) or injected (c<0)

I_{MAX} = inventory capacity

$c_{MAX}(I)$ = max deliverability rate

$c_{MIN}(i)$ = max injection rate

a(I,c) = rate of gas loss

r = risk-free discount rate

Objective: Maximize storage value

$$V(t) = \max_{c(P,I,t)} E\left[\int_0^T e^{-r\tau}\big(c - a(I,c)\big)P\, d\tau\right]$$

Subject to constraints

$$c_{min}(I) \leq c \leq c_{max}(I)$$

$$dI = -\big(c + a(I,c)\big)dt$$

Risk-adjusted spot price

- $dP = \mu_1(P,t)dt + \sigma_1(P,t)dX_1 + \sum_{k=1}^{N} \gamma_k(P,t,J_k)dq_k$

- μ = drift, probably a mean reversion
- σ = local volatility for the diffusion
- γ = Jump amount (probability distribution)
- dq = Jump indicator

- See working paper for solution using Bellman equation and PIDE
- Possible extensions
  - Stochastic volatility
  - Stochastic mean reversion
  - Path dependencies
  - Functions of outside variables, e.g. macro storage

Realistic example problem

- Stratton Ridge salt cavern gas storage facility
- Working gas capacity 2000 MMcf
  - Note MMBtu x 0.9756 = Mcf
- Deliverability of 250 MMcf/day at full capacity
- Maximum injectivity of 80 MMcf/day
- Base gas requirement 500 MMcf
- Available for 1 year lease
- Injection pump consumes 1.7 MMcf per day
- Assume Bernoulli's equation and the Ideal Gas Law apply
- Risk-neutral daily price dynamics
  - $\Delta P = 0.10 * (2.5 - P)\Delta t + 0.02P\, z$

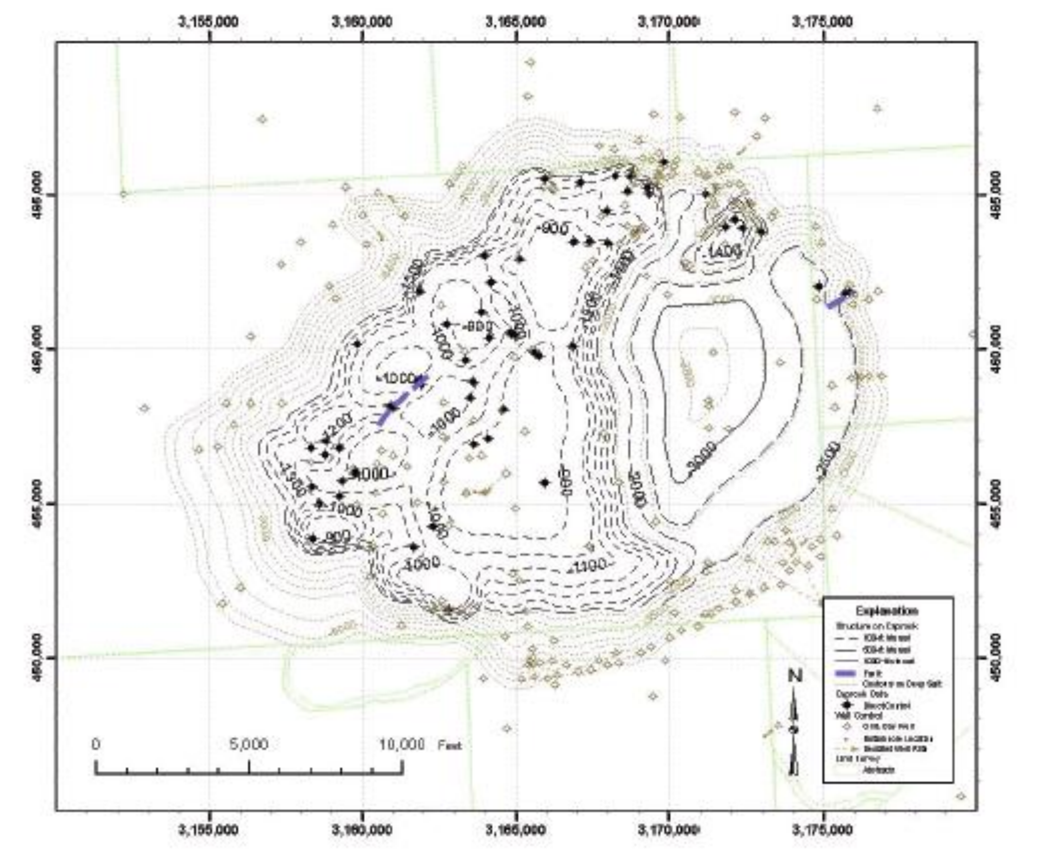
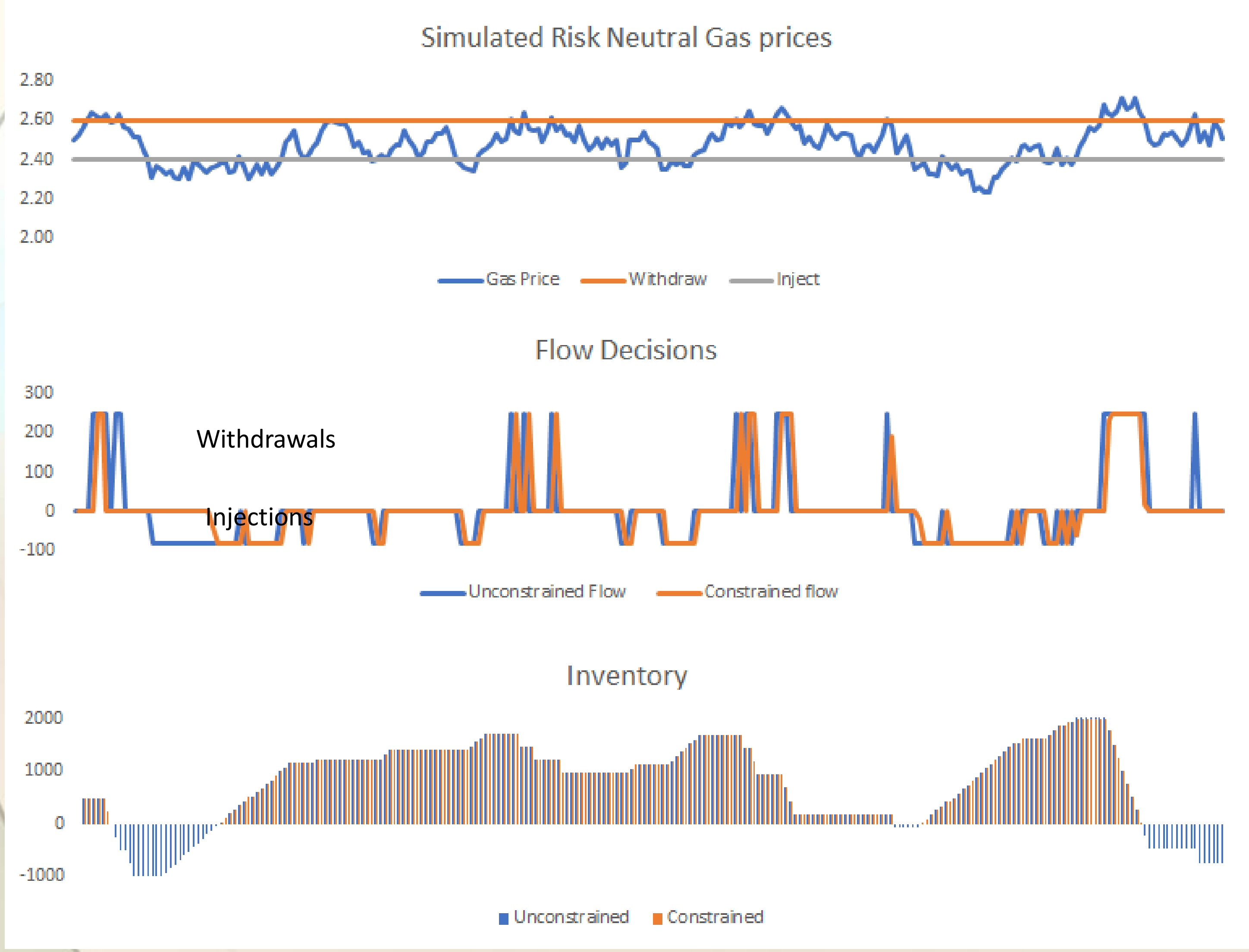


Figure 3. Structure contour map of the Stratton Ridge salt dome, drawn on the top of caprock. See Plate 2 for full-scale map. Coordinates are Texas state plane values, in feet. Elevation datum is mean sea level.

One simulation of 5000



Simplified (Excel-based) approach

- Sample daily simulation for 1 yr
- "Two price" management strategy {2.40, 2.60}
- Compute unconstrained strategy
- Impose operational constraints
- Strategy creates P/L
- Discount at risk-free rate
- Average 5000 simulations
- Valuation
    - \$322.82 (x 10,000)
    - ± 8.33

Strategy improvements: Optimal prices

Two-price policy:				
	Matrix	Use	Start	Increment
Withdraw when price exceeds	9	2.61	2.6	0.01
Inject when price falls below		2.41	2.4	0.01
Otherwise, do nothing				
Valuation				322.82
Max Error				8.33

MATRIX CODES			Withdraw	
		Down	Same	Up
	Down	1	2	3
Inject	Same	4	5	6
	Up	7	8	9

MAX		Valuations								
	380.74	271.73	297.17	323.70	296.06	322.82	352.72	320.41	349.58	380.74
		0	0	0	0	0	0	0	0	9
		Matrix Code								
	412	1	2	3	4	5	6	7	8	9
Case	1	500	577	517	511	553	503	563	554	568
	2	282	947	892	561	1,200	623	779	1,169	412
	3	644	644	784	738	738	875	839	839	1,021
	4	108	170	300	134	219	363	185	310	454
	5	67	77	77	67	77	77	67	77	77
	6	33	64	64	33	64	64	53	81	81
	7	299	382	382	319	408	408	319	408	408

- Value can increase to $380.74 by switching to {2.41, 2.61}
- Why doesn't this always work in simulation?
- Iterate until optimum is reached

Iteration to optimal strategy

Two-price policy:	Matrix	Use	Start	Increment
Withdraw when price exceeds	5	2.6	2.6	0.01
Inject when price falls below		2.51	2.51	0.01
Otherwise, do nothing				
Valuation				496.88
Max Error				10.11

MATRIX CODES		Withdraw		
		Down	Same	Up
	Down	1	2	3
Inject	Same	4	5	6
	Up	7	8	9

MAX		Valuations								
	496.88	489.01	496.31	494.69	496.55	496.88	491.68	496.37	493.17	485.56
		0	0	0	0	5	0	0	0	0
		Matrix Code								
	301	1	2	3	4	5	6	7	8	9
Case	1	918	290	19	775	39	-1	577	-1	-1
	2	389	283	347	406	301	365	417	316	374
	3	748	748	749	729	729	712	696	696	670
	4	827	819	566	880	666	386	813	507	267
	5	166	198	223	207	225	247	207	225	247
	6	127	179	179	161	226	273	164	231	345
	7	636	1,309	1,233	953	1,447	1,041	1,055	1,328	1,040

FROM
3.22 to 4.97!

Model Enhancements

- Improvements in physical constraints
  - Low pressure in storage due to low inventory reduces maximum flow available
  - High pressure due to high inventory makes injection more costly
  - Leakage increases as storage pressure increases
- Operating policy
  - Trigger prices may depend on inventory levels as well as price
  - Triggers may depend on forward price levels, not just spot
- Risk-neutral gas price simulations
  - How can these be determined rather than assumed
- Valuation strategy
  - Options on calendar spreads as better benchmarks

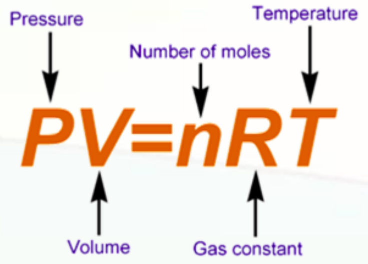
Easier

Harder

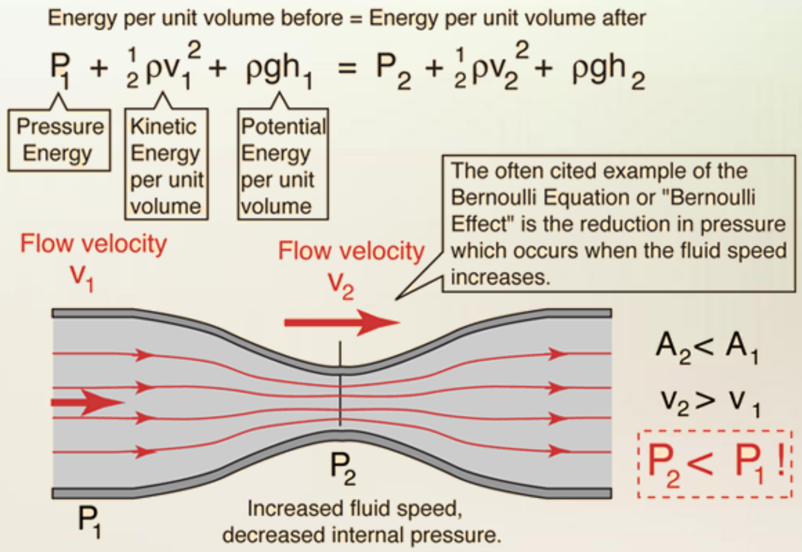
Addressing physical constraints

- Valuation strategy: Determine optimal control first, then simulate
- Control parameters (annual)
  - See derivation in the working paper
  - In the absence of leakage
    - $a(I, c) = 1.7 \times 365 \times Ind_{c<0}$
  - Using Bernoulli's law
    - $c_{max}(I) = 2040.41\sqrt{I}$
  - Using the ideal gas law
    - $c_{min}(I) = -730000\sqrt{\frac{1}{I+500} - \frac{1}{2500}}$

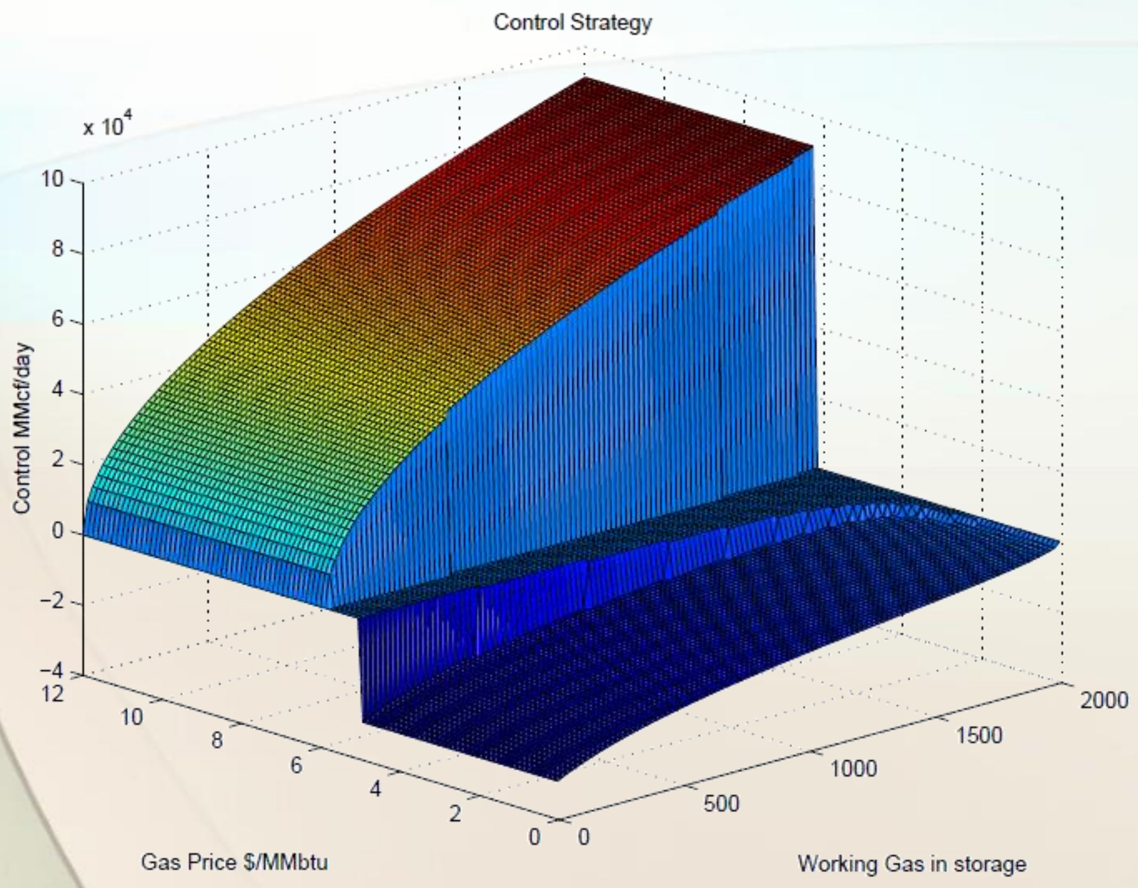
Ideal Gas Law

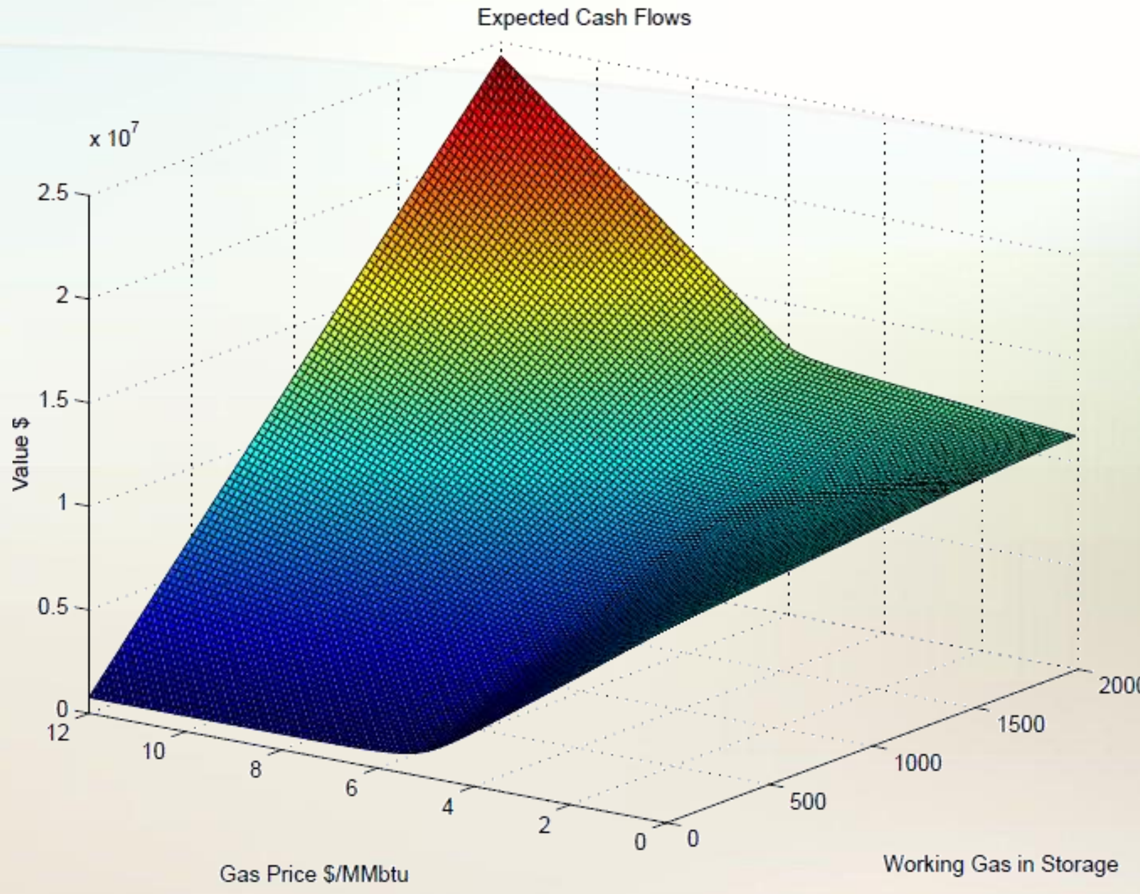


Bernoulli's Law



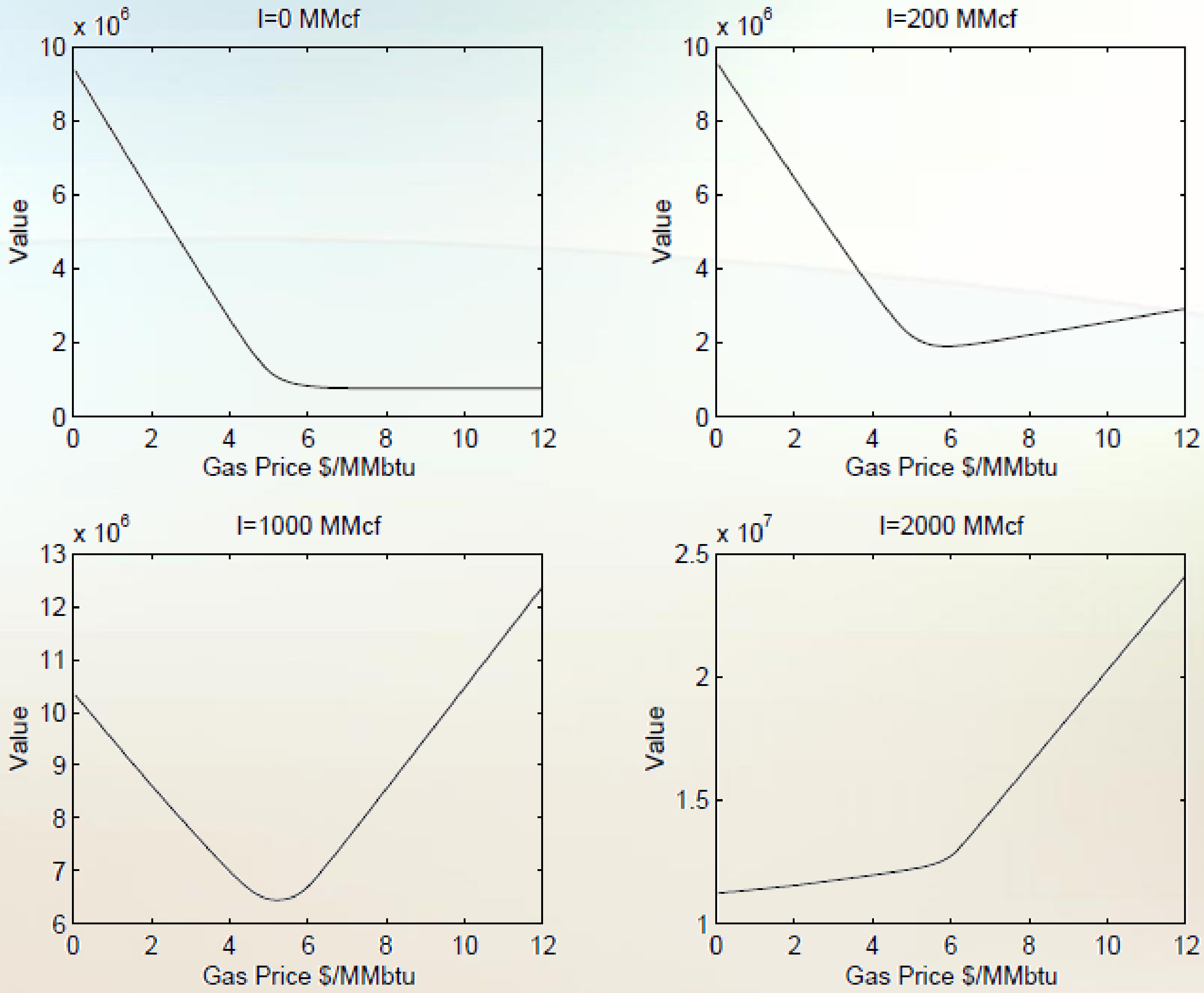
Thompson et al results (in a different price environment)





Option-like properties of the valuation

- At low inventory levels, this looks like a put option
- At intermediate inventory levels, this looks like a straddle
- At high inventory levels, this looks like a call option



The harder stuff

- How does a change in the futures curve affect operating strategy?
  - A steepening could signal more value of holding, even if prices are high
  - A flattening could signal more value of releasing, even if prices are low
  - The models assumed up until now imply futures curves and a one factor model
- Risk-neutral simulations (see Day 1 Lecture 1)
  - Each option maturity date creates an implied risk-neutral distribution of future spot prices
  - Need to assume a risk-neutral price process that is consistent with the observed distributions (if we believe market prices)

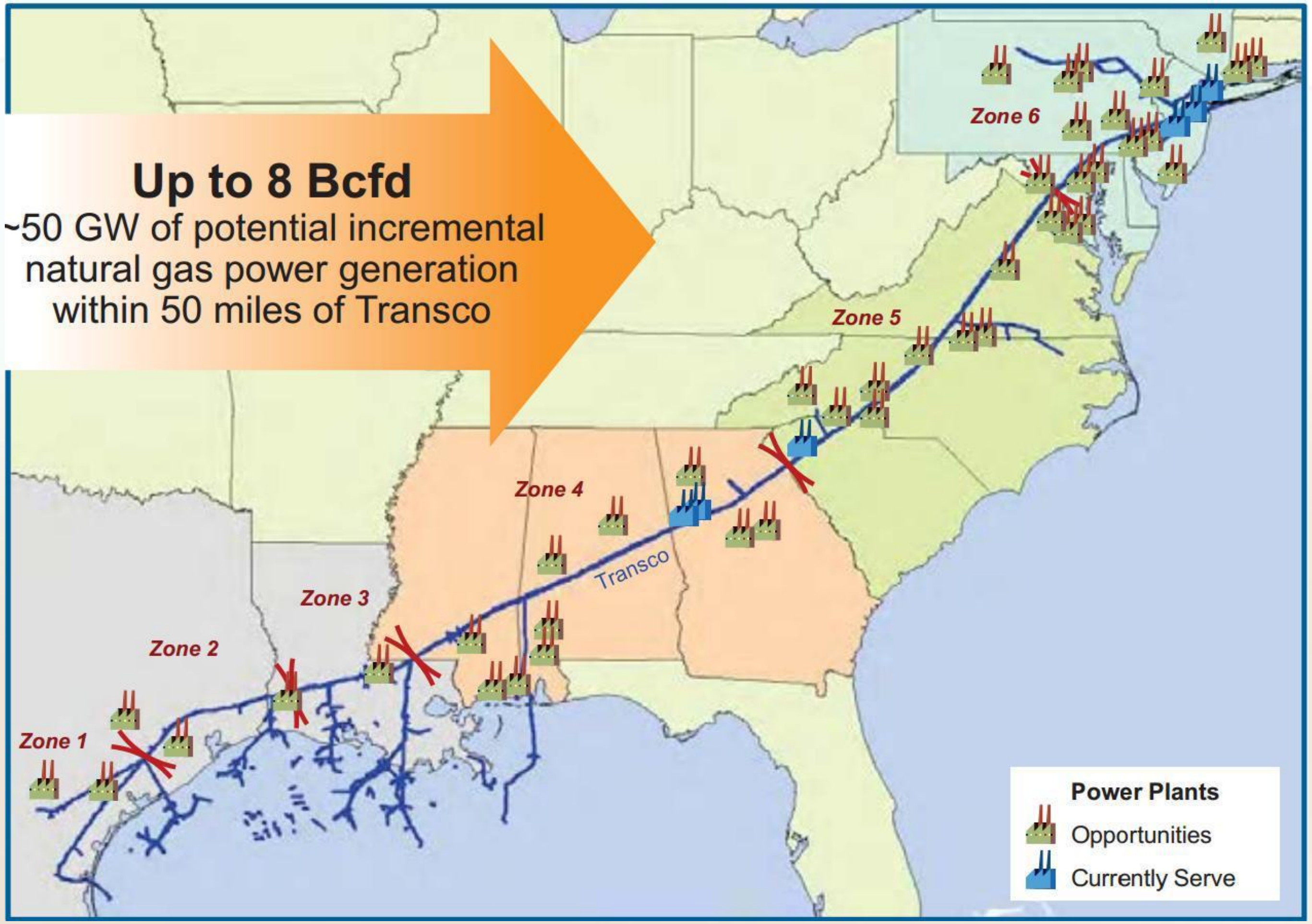
A static replication methodology

- Simulate cash flows based on strategies and constraints
- Regress the cash flows on traded futures, options and calendar spread options to find a benchmark value
  - Value of storage asset = Value of replicating portfolio
- Choose the operating strategy to maximize benchmark value

Summary of gas storage

- The gas storage option is nothing other than an option to buy or sell gas at market prices
- If spot gas were an investment asset, the value would be zero
- Since there is predictability in spot price behavior, option-like payoffs are possible
- Given the risk-neutral price process, the payouts to feasible operating strategies can be simulated
- The optimal operating strategy is the one that maximizes the value of the storage asset, i.e. the present value of the P/L at the risk-free rate
  - Hint: This works best with fixed random numbers
- Differential equations can be used to solve problems with more complex operating strategies (numerical PIDEs)
- Replication can also be used if calendar options are traded, but this also requires simulation
- In short, the storage asset behaves like a put option at low storage levels, and a call option at high storage levels.
- Storage value increases the more volatile gas prices get.
- *But be careful: Remember that the storage operators see the same screens you do!*

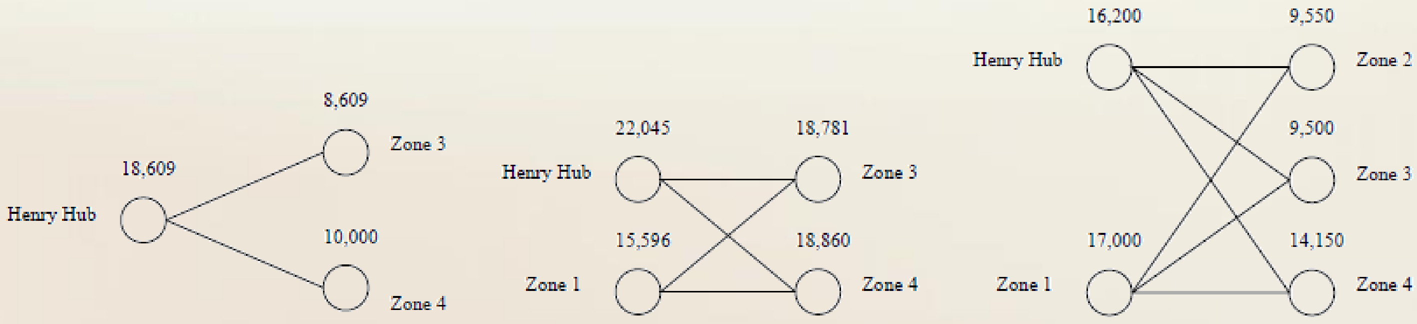
Focus on HH and Transco pipeline



Model for price generation

Table 2: Price model parameter estimates.

	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4
Mean Reversion Rate (κ_ℓ)	3.1856	4.1276	4.2477	3.5554	3.6016
Volatility (σ_ℓ)	1.0267	1.1130	1.1916	1.0922	1.1095
Instantaneous Correlation Coefficient ($\rho_{\ell\ell'}$)					
	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4
Henry Hub	1.0000	0.9118	0.9363	0.9581	0.9491
Zone 1	0.9118	1.0000	0.9011	0.9159	0.9149
Zone 2	0.9363	0.9011	1.0000	0.9329	0.9317
Zone 3	0.9581	0.9159	0.9329	1.0000	0.9814
Zone 4	0.9491	0.9149	0.9317	0.9814	1.0000



(a) 1R-2D (b) 2R-2D (c) 2R-3D

Wang, Mulan and Nicola Secomandi, “Computing the Value of the Real Option to Transport Natural gas and its Sensitivities”

Cost parameters

Table 3: Commodity and fuel rates (Source: Transco pipeline online information system).

Commodity Rate ($/MMBtu)					
	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4
Henry Hub	n.a.	0.00652	0.00507	0.00268	0.01372
Zone 1	0.00652	0.00162	0.00401	0.00652	0.01756
Zone 2	0.00507	0.00401	0.00251	0.00507	0.01611
Zone 3	0.00268	0.00652	0.00507	0.00268	0.01372
Zone 4	0.01372	0.01756	0.01611	0.01372	0.01121
Fuel Rate (%)					
	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4
Henry Hub	n.a.	1.05	0.78	0.39	2.14
Zone 1	1.05	0.27	0.66	1.05	2.80
Zone 2	0.78	0.66	0.39	0.78	2.53
Zone 3	0.39	1.05	0.78	0.39	2.14
Zone 4	2.14	2.80	2.53	2.14	1.75

Price and basis simulation process

- Create uncorrelated random numbers
- Correlate using Cholesky decomposition of correlation matrix
- Find evolution of log prices and actual prices

	Logs					*Correlated Random numbers*					*Uncorrelated Random numbers*				
Month	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4	Henry Hub	Zone 1	Zone 2	Zone 3	Zone 4
0	1.03	1.03	1.03	1.03	1.03										
1	1.02	1.02	1.01	1.01	1.00	-0.64	-0.53	-0.89	-0.93	-1.01	-0.64	0.13	-0.90	-1.09	-0.59
2	1.08	[illegible]	[illegible]	1.07	1.06	1.42	1.53	1.47	1.27	1.14	1.42	0.58	0.22	-0.68	-0.80
3	1.13	[illegible]	[illegible]	1.12	1.12	1.33	0.48	1.38	1.23	1.34	1.33	-1.75	1.06	0.30	0.58
4	1.13	[illegible]	[illegible]	1.11	1.10	[illegible]	-0.63	-0.06	-0.49	-0.66	-0.22	-1.04	0.82	-0.86	-1.27
5	1.17	[illegible]	[illegible]	1.15	1.14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	1.16	[illegible]	[illegible]	1.15	1.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	1.10	[illegible]	[illegible]	1.10	1.09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	1.05	[illegible]	[illegible]	1.06	1.05	-1.52	-1.28	-1.52	-1.56	-1.55	-1.52	0.26	-0.39	-0.40	-0.09
9	1.01	[illegible]	[illegible]	1.02	1.02	-1.63	-0.88	-0.92	-1.27	-1.00	-1.63	1.46	1.19	0.22	1.23
10	1.03	1.05	1.06	1.05	1.05	0.37	0.55	0.08	0.41	0.40	0.37	0.52	-0.95	0.25	0.19
11	1.07	1.10	1.12	1.09	1.08	0.89	0.95	1.07	0.85	0.71	0.89	0.35	0.56	-0.32	-0.86
12	1.05	1.06	1.09	1.06	1.03	-1.00	-1.17	-1.08	-1.11	-1.65	-1.00	-0.64	-0.19	-0.29	-2.93

Compute shipping values by month and zone

- For each simulation,compute the transport value as an option
- Tabulate 1000 cases

	Price sims					*Value of shipment by month and zone*			
Month	Henry Hut	Zone 1	Zone 2	Zone 3	Zone 4	HH-Z3	HH-Z4	Z1-Z3	Z1-Z4
0	2.80	2.80	2.80	2.80	2.80	0	0	0	0
1	2.77	2.78	2.74	2.74	2.73	0.00	0.00	0.00	0.00
2	2.94	2.98	2.95	2.90	2.88	0.00	0.00	0.00	0.00
3	3.10	3.07	3.15	3.07	3.06	0.00	0.00	0.00	0.00
4	3.10	3.03	3.17	3.04	3.01	0.00	0.00	0.00	0.00
5	3.21	[illegible]	[illegible]	[illegible]	3.13	0.00	[illegible]	[illegible]	0.01
6	3.18	[illegible]	[illegible]	[illegible]	3.16	0.00	[illegible]	[illegible]	0.03
7	2.99	2.91	3.08	3.01	2.99	0.00	[illegible]	[illegible]	0.00
8	2.87	2.81	2.93	2.87	2.85	0.00	[illegible]	[illegible]	0.00
9	2.74	2.76	2.85	2.77	2.77	0.02	[illegible]	[illegible]	0.00
10	2.80	2.85	2.90	2.85	2.85	0.03	0.00	0.00	0.00
11	2.92	2.99	3.06	2.97	2.96	0.04	0.00	0.00	0.00
12	2.85	2.90	2.96	2.88	2.81	0.02	0.00	0.00	0.00

Now simulate 1000 times

Option valuation and strategy optimization

- Simulate to obtain option value by month
- Choose shipment amounts to maximize net income subject to network constraints
- This is a linear program
- The same shipment values occur in every month

Month choice: 11

Transportation Spread Option Values

	HH-Z3	HH-Z4	Z1-Z3	Z1-Z4
Value	0.0436	0.0226	0.0201	0.0145
Max Error	0.0038	0.0031	0.0030	0.0026

FIX THESE	0.0446	0.0227	0.0228	0.0446	
CHOOSE SHIPMENT AMT	18781	3264	0	15596	MMBtu/d

CONSTRAINTS	22045	<=	22045
	15596	<=	15596
	18781	<=	18781
	15596	<=	18860

LINEAR PROGRAM
solved with SOLVER

VALUE 1608.115

Lease valuation is $391K

Spread option values by month					Optimized shipments					
1	0.0073	0.0002	0.0036	0.0008	18781	3264	0	15596	$	251
2	0.0124	0.0013	0.0073	0.0024	18781	3264	0	15596	$	429
3	0.0176	0.0036	0.0097	0.0041	18781	3264	0	15596	$	617
4	0.0233	0.0069	0.0111	0.0060	18781	3264	0	15596	$	825
5	0.0283	0.0097	0.0134	0.0073	18781	3264	0	15596	$	1,005
6	0.0311	0.0118	0.0131	0.0077	18781	3264	0	15596	$	1,107
7	0.0337	0.0125	0.0164	0.0104	18781	3264	0	15596	$	1,199
8	0.0346	0.0148	0.0174	0.0124	18781	3264	0	15596	$	1,237
9	0.0382	0.0190	0.0224	0.0158	18781	3264	0	15596	$	1,375
10	0.0420	0.0197	0.0185	0.0126	18781	3264	0	15596	$	1,506
11	0.0446	0.0227	0.0228	0.0165	18781	3264	0	15596	$	1,608
12	0.0468	0.0244	0.0214	0.0158	18781	3264	0	15596	$	1,688
							TOTAL per day		$	12,847
							TOTAL for year		$	390,767