SWN: SHALE GAS GROWTH[1]

1. INTRODUCTION

Claudia Gomez has recently joined the corporate finance department of an independent gas development company, Southwestern Energy Company ("SWN"), which has developed substantial shale gas reserves in Arkansas and Pennsylvania. SWN claims to be one of the lowest cost developers of natural gas reserves in the U.S.[2] Her first assignment is to provide support for Juan Lopez, SWN CEO, who believes that the required "SEC" disclosure of the present value of proven reserves discounted at 10%, and with constant prices (average prices over the last twelve months, $3.67 per MCF, way undervalues the proven reserves.

Over the past three years proven reserves had increased substantially, although reserves and present values declined significantly in 2012, when average natural gas prices

[1] © Dean A. Paxson, 2014. Parts of this case are from SWN 2013 10K, but the characters are fictitious. This case is not intended as an illustration of either good or bad business practices, and mixes hypothetical and actual data and names.

[2] See Investors Presentation Oct 2014.

reached a record low due to surplus gas production from SWN and other shale gas producers. **Table 1** shows the disclosed proven reserves, forecast future cash flows, production costs, future development costs, and other items.

Table 1

SWN PROVEN GAS RESERVES MMcf			
	2013	2012	2010
BEGIN YEAR	4,016,798	5,887,207	4,929,980
REVISIONS	325,374	-2,087,985	34,505
E,D & OA	3,283,495	918,594	1,459,428
PRODUCTION	-655,704	-564,484	-499,433
ACQUIRE	4,114		13
SALE		-136,534	-37,286
END YEAR	6,974,077	4,016,798	5,887,207
END YEAR CROSS CHECK	6,974,077	4,016,798	5,887,207
PD			
BEGIN	3,195,662	3,254,018	2,687,238
END	4,237,495	3,195,662	3,254,018
PUD			
BEGIN	821,136	2,633,189	2,242,742
END	2,736,582	821,136	2,633,189
AVERAGE PRICE ASSUMED	3.67	2.76	4.12
FUTURE CASH FLOWS $000			
INFLOWS	22,624,562	9,570,652	22,012,205
COSTS	-8,895,956	-4,737,297	-8,080,207
DEVELOP COSTS	-3,626,496	-711,050	-3,425,185
INCOME TAX	-3,223,271	-745,251	-3,366,175
NET CASH FLOWS	6,878,839	3,377,054	7,140,638
10% DISCOUNT	-3,142,795	-1,326,389	-3,689,838
SEC NET CASH FLOWS	3,736,044	2,050,665	3,450,800
ANALYSIS OF SEC STANDARDIZED MEASURE $000			
SEC BEGIN	2,050,665	3,450,800	3,013,750
PRODUCTION	-1,774,043	-1,443,606	-1,632,156
CHANGES IN PRICES	1,852,772	-2,604,591	-381,131
E,D & OA	1,454,634	549,601	1,163,992
ACQUIRE	4,914		30
SALE		-157,108	-11,761
REVISIONS	348,996	-1,109,409	34,221
DISCOUNT ACCRETION	232,385	480,315	426,245
CHANGE IN TAXES	-1,119,798	1,079,158	-103,643
CHANGE DEVELOP COSTS	26,588	2,537,419	635,386
CHANGE TIMING	658,931	-731,914	305,867
SEC END	3,736,044	2,050,665	3,450,800
SEC END CROSS CHECK	3,736,044	2,050,665	3,450,800

SWN has stated that "pre-tax PV-10 value of the estimated cash flows related to our estimated proven reserves is a useful supplement disclosure…[$5.1 billion] we understand securities analysts use pre-tax PV-10 as one measure of the value of a company's current proven reserves and to compare relative values among peer companies without regard to income taxes". Juan believes that in addition using a 10% discount rate, historical average gas prices, ignoring the improvements over time in production and reserve development costs, and indeed ignoring unproven reserves very substantially undervalues the SWN exploration, development and production portfolio.

Nevertheless, SWN values the PV methodology, as their rule for success appears to be invest when PV(10%)>1.3 Investment Cost. Although Lopez is not a big supporter of real option methodology, he wondered whether this now somewhat dated methodology might be useful in valuing proven undeveloped reserves (PUD). Natural gas prices have been very volatile in the US over the last few years, and there seemed to be times when developing reserves was hardly profitable at current gas prices. Is this volatility increasing or decreasing over time? See **Figure 1** compared to **Figure 2**.

Figure 1

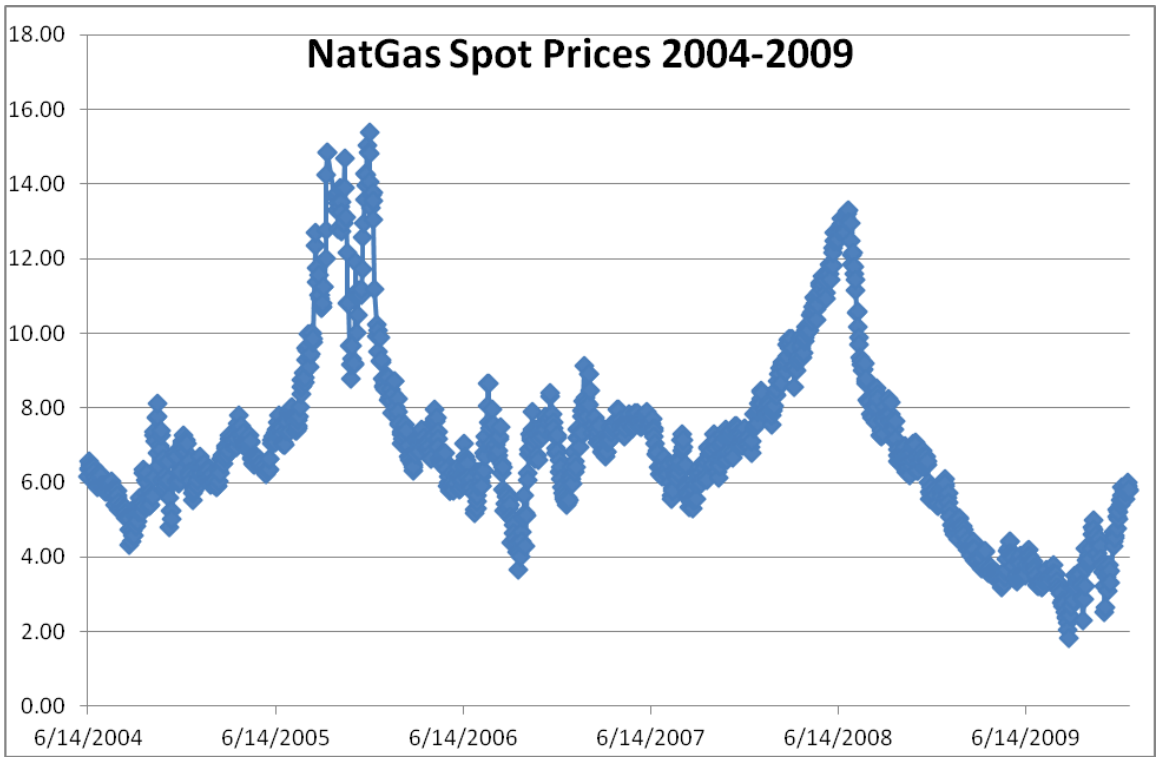
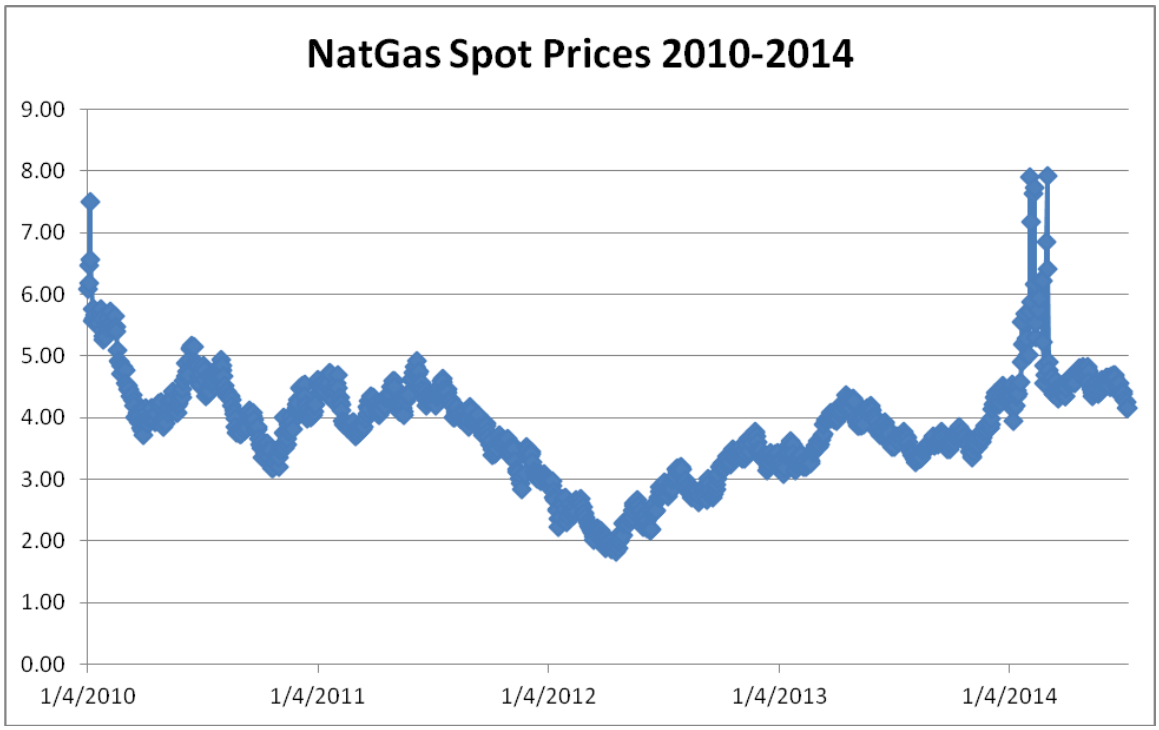


Figure 2



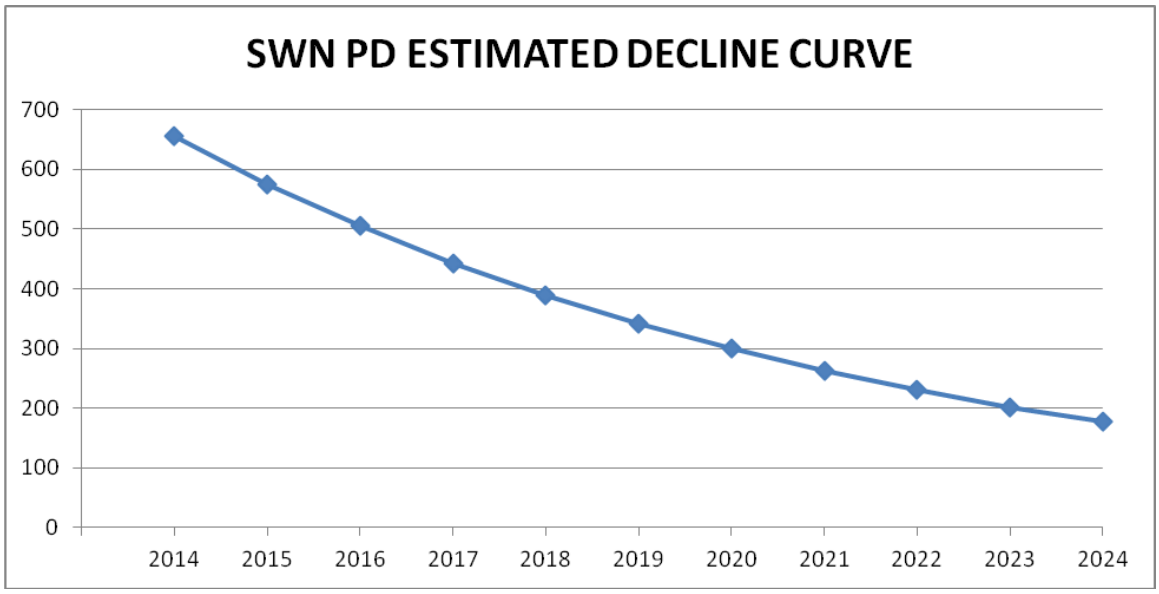
Claudia believes that long-term volatility is less than half of daily spot volatility, due to seasonality. Given the low risk of developing reserves for SWN, Lopez thinks that Claudia will be occupied sufficiently working out the model analysis and appropriate parameter values so she will produce little to surprise him over the next year "out of harm's way". The SWN people want to get on with their more important work continuing to develop reserves and sell gas in a difficult market. So while Claudia might come up with a higher value of the PUD reserves than the SEC methodology, little else will change. However, Claudia had taken an introductory course in real options, where it was argued that "not only is the NPV rule wrong, but substantially wrong, in the face of uncertainty".

2. SWN RESERVE ANALYSIS

Before trying to readjust the SEC standardized measure of reserve present value, it is first necessary to estimate the production decline curve, on which the pre-tax PV 10% of $5.1 billion is based. An external estimate shown in **Table 2** is only approximate, assumes

production ends after year twelve, production costs are $.95/MCF +$180, and production next year of 656 MMCF. If production declines at a hyperbolic rate of -.79 per annum, the gas price is constant at $3.24, the total BCF almost equals the SEC disclosure, and the 10% PV is $5.075 million. **Figure 3** shows the estimated decline curve.

Figure 3



In **Table 3**, a similar decline curve is projected for the PUD but starting at a slightly higher gas price of $3.54, and with production next year set at arbitrary figure of 20% of disclosed SEC PUD reserves. When discounted at 10% the PUD production cash flow has a present value of $3.654 million, or slightly more than the PV of the disclosed investment cost of $3.636 million. The 10% PV of PD and PUD is close to the pre-tax 10% PV figure reported by SWN. Of course, Claudia would have more accurate figures than these estimates.

Substituting these 10%PV estimates for the accounting book value of proven reserves in the December 2013 SWN balance sheet, adding the book value of other assets and subtracting the real liabilities (ignoring deferred taxes) results in net assets per share of some $15.34, as shown in **Table 4**. Then it is assumed that the gathering system assets would be worth ten times EBITDA ($376 million for 2014), the unproven properties shown in the 10K page 77 of $956 million are (arbitrarily) assumed to be worth twice

that amount, and the PUD ROV is from **Table 5**. So the initial net "appraised" value per share is $24.79 as shown in **Table 4**.

Table 4

SWN 12/2013	ASSETS	LIAB	
CURRENT	644	688	
UNPROVEN	957	1950	LTD
PD PV	5075	255	OL
PUD PV	28		
OTHER ASSETS (GATHERING)	1,590	5,401	NetAssets
TOTAL PV BASIS	8,294		
SHARES	352	**$15.34**	
ALTERNATIVE VALUES		EXCESS PER SHARE	
GATHERING	3760	$6.16	
PUD ROV	226	$0.56	
UNPROVEN ROV	1914	$2.72	
Net Appraised Assets (ROV)		**$24.79**	

3. THE SWN REAL OPTION

Claudia thinks a primary real option at SWN is the option to defer the investment decision, even if there are standard holding costs such as leasing or work requirements. Claudia is aware of several real option deferral models applied to petroleum projects, such as Tourinho (1979) and Bjerksund and Ekern (1990)[3]. Tourinho seemed the easiest model to comprehend (perhaps even Lopez could grasp the simple maths). Claudia believes if the Tourinho model as amended in Adkins and Paxson (2013) did not justify the project, greater model sophistication would be a practical waste of time. Tourinho (amended) states that the value of being able to perpetually defer an investment decision with an underlying "fundamental value" of V, when the risk less interest rate =r, the convenience yield=δ, annualized lease holding costs=η and the volatility of the project=σ, is:

$$F(V) = AV^{\beta_1} \qquad (1)$$

[3] See Adkins, R. and D. Paxson (2013), "The Tourinho Model: Neglected Nugget or a Receding Relic", European Journal of Finance, 19, 604-624; Bjerksund, P. and S. Ekern (1990),"Managing Investment Opportunities under Price Uncertainty: From 'Last Chance' to "Wait and See' Strategies", Financial Management, 19 (3), 65-83. Note Tourinho, O.A. (1979), "The Valuation of Reserves of Natural Resources: An Option Pricing Approach", Ph.D. Dissertation, University of California, Berkeley, assumed the real option holder would be required to pay an annual holding cost to maintain the concession during the deferral period.

where $\beta_1 = \frac{1}{2} - \frac{(r-\delta-\eta)}{\sigma^2} + \left\{\left[\frac{(r-\delta-\eta)}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma^2}\right\}^{\frac{1}{2}} > 1$ (2)

$$V^* = \frac{\beta_1}{\beta_1 - 1} K \quad (3)$$

$$A = \frac{V^* - K}{(V^*)^{\beta_1}} \quad (4)$$

Initially Claudia inputs a riskless interest rate of 10%, a long-term convenience yield of 10% which is at least in "the right direction" with the current backwardation (long-term futures prices less nearby futures), a lease holding cost of 10% and a volatility of 20%. As illustrated in **Table 5**, when V=3654, K=3626, the real option value ROV= 226 and V*=4258, which is the value of the project which would justify commencing the investment.

Table 5

	A	B	C
1	**PERPETUAL AMERICAN CALL**		
2	INPUT		
3	Holding Costs	0.10	
4	V	3654	PUD!$B$15
5	K	3626	PUD!$B$14
6	σ	0.20	Template Numbers
7	r	0.10	Template Numbers
8	δ_v	0.10	Template Numbers
9	OUTPUT		
10	ROV	**225.53**	IF(B4<B13,B14*(B4^B15),B11)
11	V-K	28.49	B4-B5
12	F'(V)	0.42	IF(B4<B13,B14*B15*(B4^(B15-1)),1)
13	V*	4257.52	(B15/(B15-1))*B5
14	A	0.00	(B13-B5)/(B13^B15)
15	β_1	6.74	0.5-(B7-B8-B3)/(B6^2)+SQRT(((B7-B8-B3)/(B6^2)-0.5)^2 + 2*B7/(B6^2))
16			
17	ODE	0.00	0.5*(B6^2)*(B4^2)*B18+(B7-B8-B3)*B4*B12-B7*B10
18	F''(V)	0.00	IF(B4<B13,B14*B15*(B15-1)*(B4^(B15-2)),0)
19	F'(V*)	1.00	B14*B15*(B13^(B15-1))
20	F(V*)	631.52	IF(B4<B13,B14*(B13^B15),B11)
21	V*-K	631.52	B13-B5

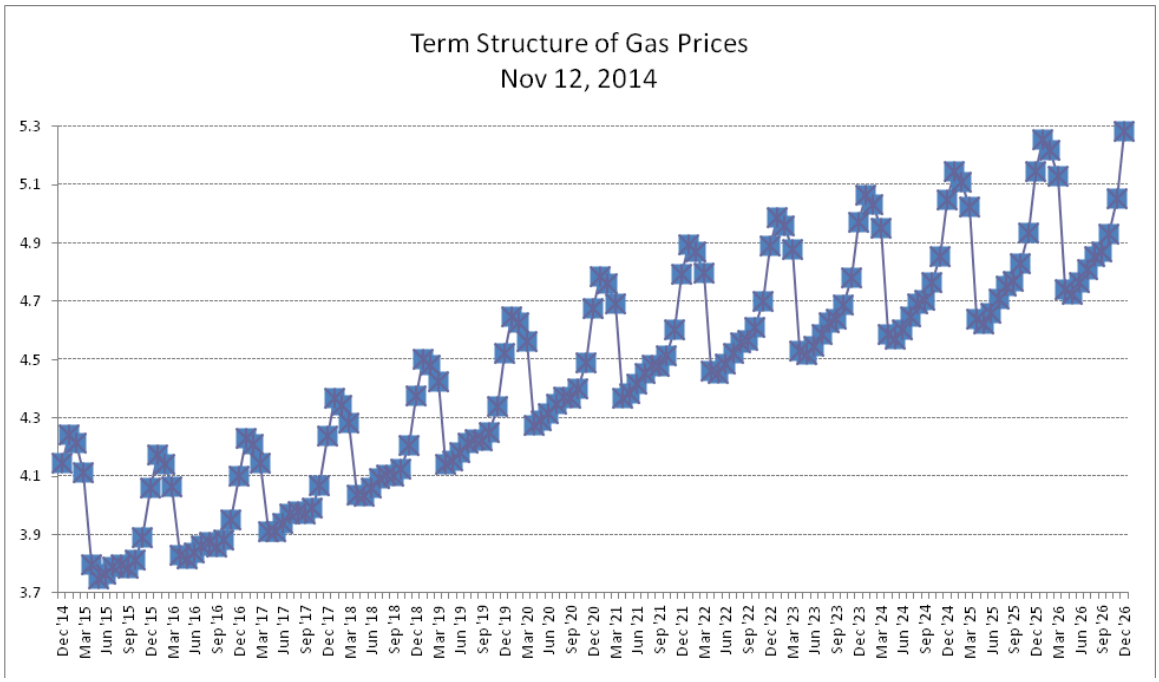
Claudia believes there are two major implications of her initial work. That indeed PUD are worth more than the PV figure, but the development of these reserves should be delayed until either more reserves are projected for the same investment cost, or natural gas prices increase. Accepting the holding cost of 10%, she believes the 10% discount

rate is not realistic in today's low interest rate environment, and that the arbitrary 20% volatility is much too low. The convenience yield is also a problem, with a easy calculation for specific natural gas future prices:

$$\delta_V = r - LN(\frac{F_t}{F_{t-1}}) \qquad (5)$$

where F_t is the futures price for year t, and F_{t-1} is the futures price for the previous year. One problem is that the convenience yield is uncertain and complicated by seasonality as shown in Figure 4, and another is that the convenience yield refers to different time periods in the future.

Figure 4



Claudia decides initially to use the nearest futures prices, Dec 2014 and Dec 2015.

CASE QUESTIONS

1. What is the historical of the volatility of natural gas prices that Claudia should use?
2. What should she provide Lopez as the best estimate of the ROV of PUD?
3. How sensitive are the real option values to changes in Claudia's assumptions?
4. What is SWN really worth, compared to the December 2014 market price of $30?

Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**SWN PROVEN DEVELOPED RESERVES**													
2	TIME	Dec-13	1	2	3	4	5	6	7	8	9	10	11	12
3	HYPERBOLIC	-0.79												
4	GAS PRICE	3.24												
5	LOC	0.95												
6	LOC Fixed	180.00												
7	DISCOUNT	0.10												
8	YEAR		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
9	PRODUCTION		656	576	505	443	389	341	299	263	230	202	177	156
10	REVENUE		2,125	1,865	1,636	1,436	1,260	1,105	970	851	747	655	575	504
11	COSTS		803	727	660	601	549	504	464	429	399	372	349	328
12	FCF		1,322	1,138	976	835	710	601	505	421	348	283	226	176
13	COSTS		$B$6+$B$5*C9											
14	INVESTMENT	$0												
15	PV	$5,075	NPV(B7,C12:N12)											
16	NPV	**$5,075**												
17	SEC	4,237												
18	TOTAL BCF	4,237	0											
19														

Table 3

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**SWN PROVEN UNDEVELOPED RESERVES**													
2	TIME		1	2	3	4	5	6	7	8	9	10	11	12
3	HYPERBOLIC	-0.75												
4	GAS PRICE	3.54	PD!$B$4+0.3											
5	LOC	0.95												
6	LOC Fixed	180.00												
7	DISCOUNT	0.10												
8	YEAR		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
9	PRODUCTION		547	448	366	299	245	200	164	134	110	90	73	60
10	REVENUE		1,937	1,584	1,296	1,060	867	709	580	474	388	317	260	212
11	COSTS		700	605	528	464	413	370	336	307	284	265	250	237
12	FCF		1,237	979	768	596	454	339	244	167	104	52	10	-25
13	PRODUCTION		0.2*B17											
14	INVESTMENT	$3,626												
15	PV	$3,654	NPV(B7,C12:N12)											
16	NPV	**$28**												
17	SEC	2,736												
18	TOTAL BCF	2,736	0											
19	SOLVER: C18=0, CHANGE B3													
20	PV PD	$5,075												
21	NPV PUD	$28												
22	Total NPV Model	$5,103												
23	Total NPV SWN	$5,100												