ANTERO RESOURCES: RISK OPTIONS[1] **24 Feb 2020**

INTRODUCTION

Mary Kirkpatrick, newly appointed Risk Manager at Antero Resources (AR), is asked to study the proposed strategic "asset monetization options" announced in December 2019, along with the authorized $600m for share repurchasing. The AR share price is at an all-time low $1.80, roughly the same as the natural gas NG price $1.80. An AR presentation shows (as of 9/2019) Net Debt/LTM Adjusted EBITDAX is 2.6x, the next to highest of 6 Appalachian E&P Peers.

AR owns 541,000 net acres in West Virginia and Ohio, targeting the Marcellus WV and Utica Ohio gas shales. The November 2018 presentation reported that the 3P (proven (PR), probable, possible) reserves are around 54.6 trillion cubic feet equivalent (Tcfe), with a PV10 $18.4B (PR $10.8B). There are some 2385 gross potential drilling locations, which could be drilled over the next several years. Note ("SEC") proven reserves disclosed in the 10K 2019 were 18.9 Tcfe, (7.2 proven undeveloped, PUD).

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[1] Parts of this case are from the AR 2019 10K and November 2018 Presentation, but the character is fictitious. Many of the numbers are the author's calculations. This case is not intended as an illustration of either good or bad business practices, and mixes hypothetical and actual data and names.

Mary believes an appropriate risk option evaluation involves measuring the exposure of AR to changes in NG and NGL prices over the next few years, over the entire proven reserves, and finally the entire 3P reserves. The PV10 picture of AR as of Dec 2019 is shown in Table 1:

Table 1 PV10 substituted for net capitalized costs of PR, deferred tax ignored.

AR 12/2019	ASSETS	LIAB		PV10	Reserves	PV10/BCFE
CURRENT	922	1040				
UNPROVEN	1369	3758	LTD			
PD PV10	4650	2645	OL +MI	4650	11739	0.3961
PUD PV10	1416		CC ??	1416	7153	0.1980
AM	1,000					
OTHER ASSETS	3,240					
TOTAL PV10 BASIS	12,597	5,154	NA	6066	18892	0.3211
SHARES	287	**$17.96**				
REFERENCE GAS PRICE NGE		$ 2.40				

AR Price Exposure and Hedging

Mary's first consideration is evaluating the reduction of price risk on proven developed reserves (hedge what you produce, not requiring further investments). AR does not specifically disclose the decline curve for aggregate production, but an approximation is shown in Table 2 for PDR and Table 3 for PUD, consistent with the "SEC" disclosure of proven reserves and PV10.

Table 2 Proven Developed Reserves

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	AR PROVEN DEVELOPED RESERVES													
2	TIME	Dec-19	1	2	3	4	5	6	7	8	9	10	11	12
3	HYPERBOLIC	-0.88												
4	GAS PRICE	$ 2.70												
5	LOC	1.90												
6	LOC Fixed	100.00												
7	DISCOUNT	10%												
8	YEAR		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
9	PRODUCTION (Bcf)		985	984	983	981	980	979	978	976	975	974	973	972
10	REVENUE	31,695.30	$ 2,659.50	$ 2,656.17	$ 2,652.85	$ 2,649.53	$ 2,646.22	$ 2,642.90	$ 2,639.60	$ 2,636.29	$ 2,633.00	$ 2,629.70	$ 2,626.41	$ 2,623.13
11	COSTS	23,504.10	$ 1,971.50	$ 1,969.16	$ 1,966.82	$ 1,964.48	$ 1,962.15	$ 1,959.82	$ 1,957.49	$ 1,955.17	$ 1,952.85	$ 1,950.53	$ 1,948.22	$ 1,945.90
12	FCF	8,191.20	$ 688.00	$ 687.01	$ 686.03	$ 685.05	$ 684.06	$ 683.08	$ 682.10	$ 681.12	$ 680.15	$ 679.17	$ 678.20	$ 677.22
13	COSTS		$B$6+$B$5*C9											
14	INVESTMENT	$0												
15	PV	$4,658	NPV(B7,C12:N12)											
16	NPV PV 10 PreTax	$4,658	$4,650											
17	SEC	11,739												
18	TOTAL BCF	11,739	0											

Table 3 Proven Undeveloped Reserves

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**AR PROVEN UNDEVELOPED RESERVES**													
2	TIME		1	2	3	4	5	6	7	8	9	10	11	12
3	HYPERBOLIC	-0.75												
4	GAS PRICE	2.80	PD!$B$4+0.77											
5	LOC	1.81												
6	LOC Fixed	100.00												
7	DISCOUNT	10%												
8	YEAR		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
9	PRODUCTION (Bcf)		1,431	1,170	957	783	640	524	428	350	287	234	192	157
10	REVENUE	20028	$4,006	$3,276	$2,680	$2,192	$1,793	$1,466	$1,199	$981	$802	$656	$537	$439
11	COSTS	14147	$2,689	$2,218	$1,832	$1,517	$1,259	$1,048	$875	$734	$619	$524	$447	$384
12	FCF	5881	$1,316	$1,058	$848	$675	$534	$418	$324	$247	$184	$132	$90	$55
13	PRODUCTION (Bcf)		0.2*B17											
14	INVESTMENT	$2,772												
15	PV	$4,196	NPV(B7,C12:N12)											
16	NPV	**$1,424**	$1,416											
17	SEC	7,153												
18	TOTAL BCF	7,153	0											
19	SOLVER: C18=0, CHANGE B3													

Mary has not been given strict guidelines on what constitutes adequate hedging, but she realizes there could be at least five levels of price exposure protection: (1) hedge 1-3 years of production from proven developed producing reserves, (2) hedge all proven developed reserves, (3) hedge PD and PUD reserves, (4) hedge selectively NG and/or NGL prices, given the illiquidity and backwardation of propane futures prices, (5) consider hedging 3P reserves. While it is relatively easy to measure the percentage of each year's production hedged (1), hedge ratios for all reserves, even if feasible, should consider the discount factor. As of Dec 2019, AR held fixed price swap contracts for 1.7 Tcf NG and 15 MMBbls of NGL and oil.

Risk of Default

The real value of a debt claim D^* is derived in Leland (1994) and shown in ROV CH 10A, as:

$$D^* = \frac{C}{r} + [(1-\alpha)V_B - \frac{C}{r}](\frac{V_B}{V})^{\beta_2} \tag{1}$$

$$V^* = V + \frac{\tau C}{r}[1-(\frac{V_B}{V})^{-\beta_2}] - \alpha V_B(\frac{V_B}{V})^{-\beta_2} \tag{2}$$

$$E^* = V - D + [D - V_B](\frac{V_B}{V})^{-\beta_2} = V^* - D^* \tag{3}$$

$$V_B = [(1-\tau)\frac{C}{r}](\frac{-\beta_2}{1-\beta_2}) \tag{4}$$

$$\beta_2 = \frac{1}{2} - \frac{(r-\delta)}{\sigma^2} - \sqrt{\left[\frac{(r-\delta)}{\sigma^2} - \frac{1}{2}\right]^2 + \frac{2r}{\sigma^2}} < 0 \tag{5}$$

where C=coupon, r=riskless rate, δ=convenience yield, σ=asset volatility, debt D=C/r, α is the loss in liquidation, τ is the tax rate, V_B is the value of V at which management chooses optimally to default, V* is the option adjusted V, and E* is the real equity option value.

Table 4 is a template for estimating D*, V* and E* with hypothetical inputs, accounting equity E=50, # shares=100, market price is $.25 (half of E/#).

Table 4

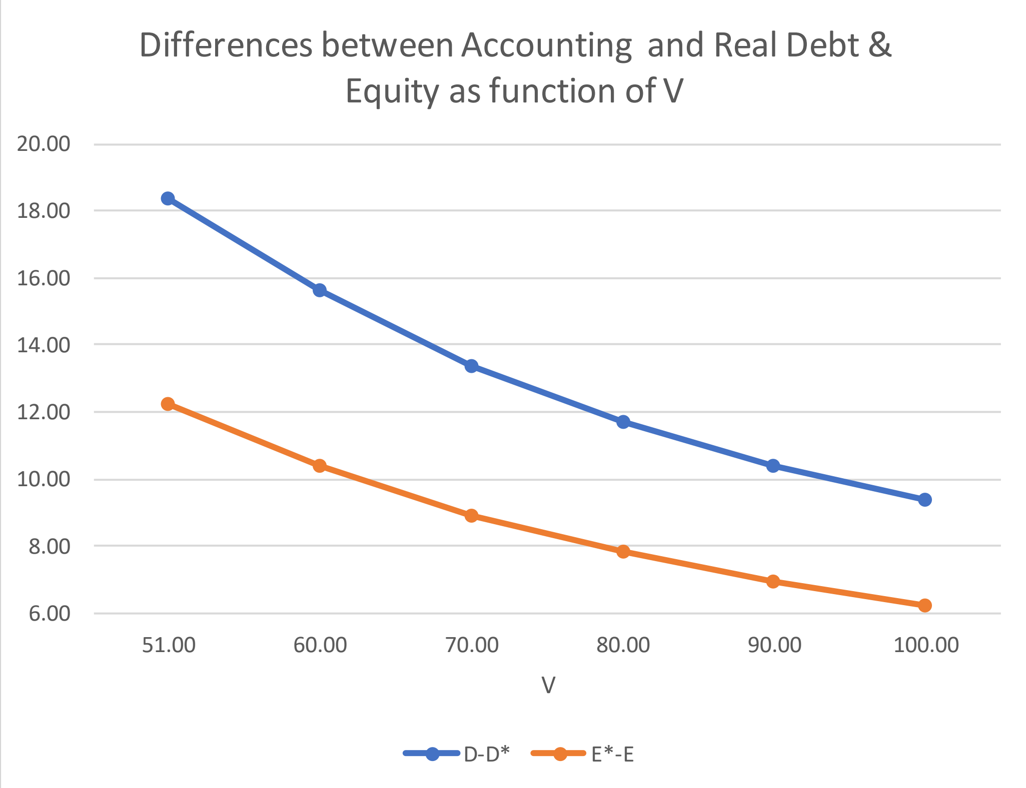
	A	B	C
1	**Base Case for Equity Strategy**		
2	V	100.00	
3	D	50.00	B8/B9
4	E	50.00	B2-B3
5	V*	96.88	B2+(B12*B8/B13)*(1-(B19/B2)^-B20)-B11*B19*(B19/B2)^-B20
6	D*	40.63	(B8/B13)+((1-B11)*B19-(B8/B13))*(B19/B2)^-B20
7	E*	56.25	B5-B6
8	C	2.00	
9	δ	0.04	
10	σ	0.20	
11	α	0.50	
12	τ	0.00	
13	r(f)	0.04	
14	S # Shares	100.00	
15	E/#	0.50	B4/B14
16	E*/#	0.56	B7/B14
17	MP	0.25	
18	Market Cap	25.00	B17*B14
19	V_B	25.00	(1-B12)*(B8/B13)*(-B20/(-B20+1))
20	β_2	-1.00	(0.5-(B13-B9)/(B10^2)-SQRT((0.5-(B13-B9)/(B10^2))^2+2*B13/(B10^2)))
21	MP/NAV	50.00%	B17/B15
22	MP/ROV	44.44%	B17/B16
23	D/V	50.00%	B3/B2
24	D/V*	51.61%	B3/B5
25	D*/V*	41.94%	B6/B5

When D=.5 V, the optimal default is at 25, so there is a slight risk of voluntary liquidation, and a slight addition to the accounting equity value per share (E/#) for the call option aspect of leveraged equity.

Table 5 shows that the risk of default increases as V falls (as surely has occurred over the past year, with the collapse of NG prices.

Table 5

D/V	98.04%	83.33%	71.43%	62.50%	55.56%	50.00%
D/V*	111.43%	91.25%	76.29%	65.71%	57.78%	51.61%
D*/V*	70.46%	62.74%	55.86%	50.31%	45.75%	41.94%
D-D*	18.38	15.63	13.39	11.72	10.42	9.38
E*-E	12.25	10.42	8.93	7.81	6.94	6.25
V	51	60	70	80	90	100
D*'(V)	0.3604	0.2604	0.1913	0.1465	0.1157	0.0938



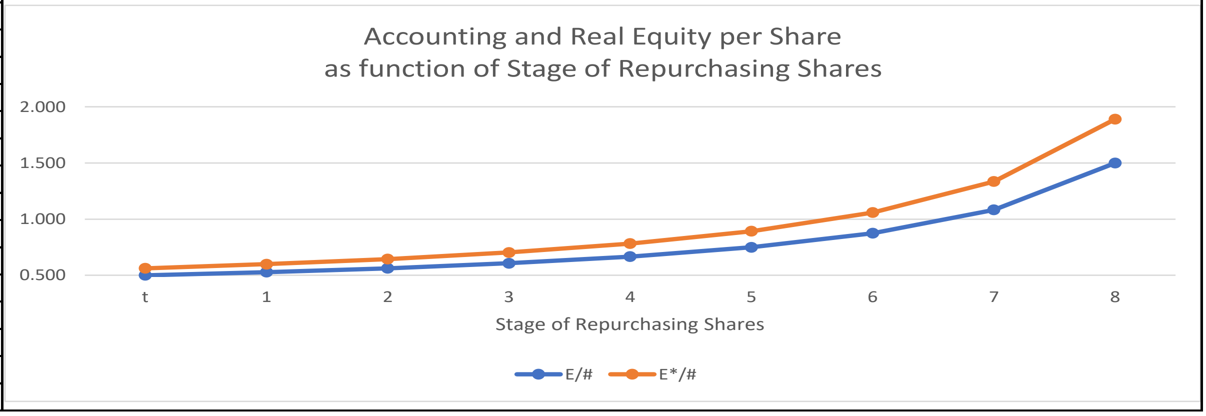
Share Repurchasing

AR has authorized in October 2018 a share repurchasing program of some $600m, with limited action thus far, and expiring in March 2020. But Mary wants to examine what might happen across stages of repurchasing (around 10 shares each stage, or 10% of the initial outstanding shares).

This assumes the base case parameter values in Table 4, the face value of debt, coupon, interest rate, asset yield and volatility, and foreclosure costs are all constant, no taxes or transaction costs, that part of V can be converted into cash, and that the market value of debt and credit rating are ignored. V and D are perpetuities, and only the default option is considered.

Table 6

	A	B	C	D	E	F	G	H	I	J
21	MP/NAV	50.00%	47.37%	44.44%	41.18%	37.50%	33.33%	28.57%	23.08%	16.67%
22	MP/ROV	44.44%	41.74%	38.78%	35.53%	31.95%	28.00%	23.61%	18.71%	13.22%
23	D/V	50.00%	51.28%	52.63%	54.05%	55.56%	57.14%	58.82%	60.61%	62.50%
24	D/V*	51.61%	53.03%	54.52%	56.10%	57.78%	59.57%	61.48%	63.52%	65.71%
25	D*/V*	41.94%	42.83%	43.76%	44.73%	45.75%	46.81%	47.92%	49.09%	50.31%
26	Repurchase	10	10	10	10	10	10	10	10	10
27	Price	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
28	K Cost	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
29	Drill Return	1.1111	1.2500	1.4286	1.6667	2.0000	2.5000	3.3333	5.0000	10.0000
30	Solve	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	SOLVER SUM	0.00	CHANGE B29:J29		SOLVE	(B32+B29*B28-B33)/B36-C34				
32	V	100.00	97.50	95.00	92.50	90.00	87.50	85.00	82.50	80.00
33	D	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
34	E/#	0.500	0.528	0.563	0.607	0.667	0.750	0.875	1.083	1.500
35	E*/#	0.563	0.599	0.645	0.704	0.782	0.893	1.059	1.336	1.891
36	# Shares	100	90	80	70	60	50	40	30	20
37	Stage	t	1	2	3	4	5	6	7	8



The cost at each stage of repurchasing shares is K_{t+}, the repurchase price times 10, the number of shares repurchased at each stage. The next stage V_{t+1} is reduced by K_t, the repurchasing cost. The new accounting equity per share is the next stage (V_{t+1} less D_{t+1})/remaining shares, or E_{t+1}/S_{t+1}. What is the equivalent return on drilling (d_t) that could have produced the same accounting E/Share? This involves solving the following equation:

$$(V_t + d_t * K_t - D_t) / S_t - E_{t+1} / S_{t+1} = 0 \tag{6}$$

where K_t=repurchasing cost, d_t is the required return on drilling, S_t is the number of outstanding shares. The return on drilling has to result in an equivalent increase in the value per share for the next period as E_{t+1}/S_{t+1}. An easy alternative expression is:

$$d_t = \frac{S_t(E_t - K_t)/S_{t+1} - E_t}{K_t} \tag{7}$$

If successive repurchasing of the shares can be achieved at the current stock market price of $ .25, then the appraised equity value per share would steadily increase to three times the current value, if only 10% of the initial shares are then outstanding. The drilling return of 1.1111 times 2.5 (K) equals 2.7778 which is the ratio of 5.27778/2.5 -1, that is adding 2.7778 to V over the investment cost. The drilling return would have to exceed 1000% to justify drilling rather than repurchasing shares at the 8th stage. Is this feasible? Only if the lenders would be satisfied that leverage is not excessive (D/V=62.5% at the 8th stage), and if investors are still willing to sell shares back to the firm at the initial market price.

PROJECT QUESTIONS

1. **Help Mary understand the exposure of AR to NG and NGL prices, showing the change in PV10 of 10% +/- in prices (assume a portfolio of 2/3 NG and 1/3 NGL), revising Tables 1, 2 and 3.**
2. **What are the recalculated NG, NGL, AR volatilities, based on your reasonable assumptions, updated to Feb 2020?**
3. **With the PV10 in the Dec 2019 10K, perhaps updated based on current NG prices (rather than the average price over the last 12 months), what is the risk of default (D/V and V_B/V)?**
4. **Should AR repurchase shares at the current share price [$1.65 on 24 Feb 2020]?**