Adelman's Logic Explained

Sir--

You point out ("Vagit Rockefeller", July 16th) that Royal Dutch/Shell is valued at $94 billion, or $5.36 per barrel of proven reserves, whereas Russia's Lukoil is worth only $850m, or five cents a barrel. But the value of a barrel of oil in the ground depends on the time taken to get it above ground. Lukoil's reserves are being depleted at 2.36% a year; Shell's, at 6.54%. The annual percentage decline is typically a little less, so a barrel of Shell oil will, on average, be sold in 10.4 years; and a barrel of Lukoil in 29.0 years. If one discounts the receipts at 10%, the present value of Shell's production stream is about one third of the well-head value—not far from an industry rule-of thumb—whereas Lukoil's present value is only 4.7% of the well-head value. If one discounts Lukoil receipts by 15%, which may not be an excessive allowance for capital scarcity, the present value is a little under 1%.

Therein lies the difference in value between Lukoil and Shell. And it explains why there is a huge gain in applying money and know-how to deplete the Lukoil reserves more quickly. One can only hope that Lukoil and the Russian government will accept that time is money, and that they are better off with a less-than-perfect share of the gains than with holding on to a sterile ownership.

M.A. ADELMAN

MIT

Cambridge, Massachusetts

Note: Professor Adelman is a prominent economist at the Massachusetts Institute of Technology. The letter above (taken from *The Economist* magazine of August 6, 1994) is Adelman's response to an article in *The Economist* discussing the relative values of Lukoil (formerly the Russian state oil company) and Royal/Dutch Shell. Note Adelman's use of NPV to develop a rule of thumb for valuing oil reserves. The applicability to the "Gulf Oil" case is clear.

Suppose you have 100 barrels of oil today, and suppose you extract 6.54% per year of this supply. Here's what reserves will be in the following years:

	A	B	C	D
4	extraction rate	6.54%		
5	half-life	10.2481	<-- =LOG(0.5)/LOG(1-B4)	
6	discount rate	10%		
7	discount factor	0.376533	<-- =1/(1+B6)^B5	
8				
9				
10		**barrels**		
11	**year**	**left**	**extracted**	
12	0	100		
13	1	93.46	6.54	
14	2	87.35	6.11	
15	3	81.64	5.71	
16	4	76.30	5.34	
17	5	71.31	4.99	
18	6	66.64	4.66	
19	7	62.28	4.36	
20	8	58.21	4.07	
21	9	54.40	3.81	
22	10	50.85	3.56	
23	11	47.52	3.33	
24	12	44.41	3.11	
25	13	41.51	2.90	

Somewhere between years 10 and 11, you've extracted exactly **half the oil**. This is the number Adelman refers to. For Lukoil, extraction rate 2.54%, and the relevant number is 29 years:

	A	B	C	D
4	extraction rate	2.36%		
5	half-life	29.02269	<-- =LOG(0.5)/LOG(1-B4)	
6	discount rate	10%		
7	discount factor	0.062903	<-- =1/(1+B6)^B5	
8				
9				
10		**barrels**		
11	**year**	**left**	**extracted**	
12	0	100		
13	1	97.64	2.36	
14	2	95.34	2.30	
15	3	93.09	2.25	
16	4	90.89	2.20	
36	24	56.37	1.36	
37	25	55.04	1.33	
38	26	53.74	1.30	
39	27	52.47	1.27	
40	28	51.24	1.24	
41	29	50.03	1.21	
42	30	48.85	1.18	

Adelman estimates the value of an **average barrel of oil extracted** (for Gulf) by:

$$\frac{net\ value\ per\ barrel}{\left(1+discount\ rate\right)^{average\ extraction\ half-life}}$$

As the spreadsheet above shows, when the discount rate is 10% and the half-life is 10.24, this number becomes 0.3765 * net value.

To calculate the half-life

We have to find *n* such that:

$$\left(1-extraction\ rate\right)^{n}=0.5$$

Taking the log of both sides gives:

$$n=\frac{Log\left(0.5\right)}{Log\left(1-extraction\ rate\right)}$$