The Effect of Margin and Reserves/Production Ratio on Oil and Gas Transaction Multiples

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Oil and gas transactions are often characterized in terms of multiples.

Transaction multiples are used to describe oil and gas deals:

- “That deal values the reserves at $20 per barrel.”
- “The production from that deal sold at $2,000 per flowing M.”
- “That asset sold for 5 times cash flow.”

What metric is a good price?

- It depends.
- On a lot of things
- It is not straightforward
Definition of Multiples

**Reserves Multiple** – Transaction Value / Proved Reserves
- Proved reserves includes PDP, PDNP, and PUD
- Usually SEC Proved Reserves, (sometimes Market Proved Reserves)
  - Strip commodity price forecast may be significantly different than SEC historical 12-month average price

**Production Multiple** – Transaction Value / Current Production Rate
- Current production rate is usually averaged over a short period of time (1-3 months)

**Cash Flow Multiple** – Transaction Value / Current Rate of Cash Flow
- Current cash flow rate is usually averaged over a short period of time (1-3 months)

<table>
<thead>
<tr>
<th>Multiple</th>
<th>Oil Units</th>
<th>Gas Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves</td>
<td>$ / bbl or $ / boe</td>
<td>$ / Mcf or $ / Mcfe</td>
</tr>
<tr>
<td>Production</td>
<td>$ / (bbl/day) or $ / (boe/day)</td>
<td>$ / (Mcf/day) or $ / (Mcfe/day)</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>$ / $ (dimensionless)</td>
<td></td>
</tr>
</tbody>
</table>
### Intrinsic Value Depends on Decline Rate

<table>
<thead>
<tr>
<th>Metric</th>
<th>Intuitive Thought</th>
<th>Impact on Multiple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Low-decline production has more value than high-decline production</td>
<td>Production Multiple depends on how the production rate declines</td>
</tr>
<tr>
<td>Cash Flow</td>
<td>Low-decline cash flow has more value than high-decline cash flow</td>
<td>Cash Flow Multiple depends on how the cash flow rate declines</td>
</tr>
<tr>
<td>Reserves</td>
<td>High-decline reserves have more value than low-decline reserves</td>
<td>Reserves Multiple depends on how quickly the reserves get produced</td>
</tr>
<tr>
<td>Margin</td>
<td>High-margin production and reserves has more value than low-margin production and reserves</td>
<td>Production and Reserves Multiples will depend on margin</td>
</tr>
</tbody>
</table>

Decline rate often characterized by R / P (reserves / production) ratio
- R / P = Reserves / (Production x 365)
- Has units of “years”
- This is a ratio, and is not the length of the life of the production forecast
- High R / P has low decline and long life
Production and Cash Flow Multiple
Which 10 MMcf/day well would you rather have?

**Exponential Decline**
\[ q = q_i e^{-Dt} \]

**Hyperbolic Decline (b=1.5)**
\[ q = q_i (1 + bD_t)^{-1/b} \]

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**Cartesian Plot**
- **R / P = 10 yr**
- **R / P = 2 yr**

**Semi-log Plot**
- **Gas Rate (MMcf/day)**
- **Cumulative Gas Production (Bcf)**

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**Cartesian Plot**
- **R / P = 21 yr**
- **R / P = 10 yr**

**Semi-log Plot**
- **Gas Rate (MMcf/day)**
- **Cumulative Gas Production (Bcf)**

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Although the initial rate is identical, the low-decline well (red) has higher recovery and more value, due to more volume over time. Cash Flow acts similarly. **Production and Cash Flow are more valuable for high R / P assets.**
Reserve Multiple
Which 20 Bcf EUR well would you rather have?

Exponential Decline
\[ q = q_i e^{-Dt} \]

Hyperbolic Decline (b=1.5)
\[ q = q_i (1 + bD_i t)^{-1/b} \]

Although the reserves are identical, the high-decline well with higher initial rate has accelerated production and more value, due to the time value of money. 
Reserves are more valuable for low R/P assets.
Tradition Correlation of Reserve and Production Multiples as a Function of R/P

We can do better than this!

Source: Raymond James A&D Insight 1Q 2019 A&D Themes // 1Q 2019 Basin Activity Overview // U.S. E&P Asset Transactions. Note: This report was prepared by Raymond James & Associates’ Investment Banking Department and is for information purposes only. This report is not a product of Raymond James & Associates’ Research Department; recipients of this report should not interpret the information herein as sufficient grounds for an investment decision or any other decision. Raymond James does not guarantee that the information in this report is accurate or complete.”
1. Commodity product index prices are different
2. Commodity differentials are different
3. Operating costs are different
4. Gathering and transportation costs are different
5. Severance and ad valorem taxes are different
6. Royalty burden is different
7. Mix of developed and non-producing/undeveloped reserves is different
8. Mix of oil, gas, and NGL’s is different
9. Unquantified upside may or may not exist
Margin

Margin accounts for a number of variables that impact market value of an asset, and the implied multiples.

- Operating profit generated per unit of production
- Product price, less product differential, operating costs, taxes, and royalty
- High-margin asset is more valuable than a low-margin asset
Synthetic Multiples

- Market value is related to intrinsic value
- Intrinsic value can be calculated from Discounted Cash Flow
- Economic runs were made that calculate value and multiples
  - Varied R/P, Margin, and Discount Rate
  - Production Multiple is PV10 / initial production rate
  - Reserves Multiple is PV10 / reserves
  - Cash Flow Multiple is PV10 / initial annualized cash flow
Production and Reserve Multiples - Gas
Production and Reserve Multiples - Oil

Production Multiple

Reserves Multiple

Net Margin ($/bbl)  
- 10  
- 20  
- 30  
- 40  
- 50

PV 10 / IP (M$/bbl/d)  
- R / P (years)

PV 10 / Reserves ($/bbl)  
- R / P (years)
Effect of Discount Factor on Multiples – Gas
$0.40/Mcf margin

- Lower discount factors give higher multiples
- Discount factor matters more for long-lived (high R / P) profiles
Both high- and low-margin runs gave same ratio of PV/EBITDA, so all margin curves collapse to a single curve for a given discount rate.

Identical curves for both oil and gas.
Effect of Discount Factor on Multiples – Gas
$1.50/Mcf margin

Hyperbolic decline gives lower multiples for a given margin and R/P.
Production Multiples Equations

Power fit (log-log plot) gave best correlation

\[ M_P = F_M \times F_R \times F_D \]

### Production Multiple - Oil

\[ F_R = e^{\left( C_0 + C_1 \ln\left( \frac{R}{P} \right) + C_2 \ln^2\left( \frac{R}{P} \right) + C_3 \ln^3\left( \frac{R}{P} \right) + C_4 \ln^4\left( \frac{R}{P} \right) \right)} \]

\[ F_M = 105.263 \times M \]

- \( C_0 = 1.307 \)
- \( C_1 = 0.870 \)
- \( C_2 = 0.00803 \)
- \( C_3 = -0.0459 \)
- \( C_4 = 0.00596 \)

### Production Multiple - Gas

\[ F_R = e^{\left( C_0 + C_1 \ln\left( \frac{R}{P} \right) + C_2 \ln^2\left( \frac{R}{P} \right) + C_3 \ln^3\left( \frac{R}{P} \right) + C_4 \ln^4\left( \frac{R}{P} \right) \right)} \]

\[ F_M = 2.5 \times M \]

- \( C_0 = 5.025 \)
- \( C_1 = 0.966 \)
- \( C_2 = -0.105 \)
Reserves Multiples Equations
Power fit (log-log plot) gave best correlation

\[ M_R = F_M \times F_R \times F_D \]

**Reserves Multiple - Oil**

\[ F_R = e^{\left( C_0 + C_1 \ln \left( \frac{R}{P} \right) + C_2 \left[ \ln \left( \frac{R}{P} \right) \right]^2 \right)} \]

\[ F_M = 0.105263 \times M \]

\[ C_0 = 2.297 \]
\[ C_1 = -0.0310 \]
\[ C_2 = -0.106 \]

**Reserves Multiple - Gas**

\[ F_R = e^{\left( C_0 + C_1 \ln \left( \frac{R}{P} \right) + C_2 \left[ \ln \left( \frac{R}{P} \right) \right]^2 \right)} \]

\[ F_M = 2.5 \times M \]

\[ C_0 = -0.875 \]
\[ C_1 = -0.0337 \]
\[ C_2 = -0.105 \]
Logarithmic fit (semi-log plot) gave best correlation

\[ M_{CF} = F_R \times F_D \]

\[ F_R = C_0 + C_1 \ln \left( \frac{R}{P} \right) + C_2 \left[ \ln \left( \frac{R}{P} \right) \right]^2 \]

\[ C_0 = 1.336 \]
\[ C_1 = 1.474 \]
\[ C_2 = 0.173 \]
Effect of Discount Rate
Logarithmic fit (semi-log plot) gave best correlation

\[ F_D = 1 + S \left( \ln \frac{D}{10} \right) \]

Where \( S \) is a slope on a logarithmic plot, calculated as a function of \( R / P \)

“Ratio of Multiple” is the multiple for a given discount rate divided by the multiple for a 10% discount rate

\[ S = c_0 + c_1 \ln \left( \frac{R}{P} \right) + c_2 \left[ \ln \left( \frac{R}{P} \right) \right]^2 + c_3 \left[ \ln \left( \frac{R}{P} \right) \right]^3 \]

<table>
<thead>
<tr>
<th>( D ) 6-10 %</th>
<th>( D ) 10-20 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>( c_0 = -0.08817 )</td>
<td>( c_0 = -0.11944 )</td>
</tr>
<tr>
<td>( c_1 = -0.02934 )</td>
<td>( c_1 = -0.10581 )</td>
</tr>
<tr>
<td>( c_2 = -0.08313 )</td>
<td>( c_2 = -0.03853 )</td>
</tr>
<tr>
<td>( c_3 = 0.007425 )</td>
<td>( c_3 = 0.00818 )</td>
</tr>
</tbody>
</table>
### Oil Inputs
- **Production Rate**: 10,000 bbl/day
- **Oil Reserves**: 36,500 Mbbl
- **Oil Cash Flow**: 73,000 M$/year
- **Calculated R/P**: 10.00 years
- **Calculated Margin**: 20.00 $/bbl

### Oil Transaction Multiple Assumptions
- **Discount Rate**: 10.00%
- **Reserves to Production Ratio**: 20.00 years
- **Margin**: 2.30 $/bbl
- **ln (R/P)**: -0.51 slope on log plot

### Oil Production Multiple Calculation
- **Factor for margin, \( F_M \)**: 2.105
- **Factor for R/P ratio, \( F_R \)**: 19.30
- **Factor for discount rate, \( F_D \)**: 1.00
- **Oil production multiple, \( M_P \)**: 40,628 ($/bbl/day)

### Oil Reserve Multiple Calculation
- **Factor for margin, \( F_M \)**: 2.11
- **Factor for R/P ratio, \( F_R \)**: 5.28
- **Factor for discount rate, \( F_D \)**: 1.00
- **Oil reserves multiple, \( M_P \)**: 11.11 ($/bbl)

### Oil Cash Flow Multiple Calculation
- **Factor for R/P ratio, \( F_R \)**: 5.65
- **Factor for discount rate, \( F_D \)**: 1.00
- **Cash flow multiple, \( M_{CF} \)**: 5.65 ($/$)

### Oil Value Calculation
- **Based on Oil Production Multiple (M$)**: 406,276
- **Based on Oil Reserve Multiple (M$)**: 405,601
- **Based on Oil Cash Flow (M$)**: 412,248

### Graphing Inputs
- **Production Multiple-Low**: 35 ($/Mbbl/d)
- **Production Multiple-High**: 45 ($/Mbbl/d)
- **Reserve Multiple-Low**: 11 ($/bbl)
- **Reserve Multiple-High**: 13 ($/bbl)
- **Cash Flow Multiple-Low**: 5.5 ($/$)
- **Cash Flow Multiple-High**: 6 ($/$)

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**Notes:**
- For the oil production multiple calculation, the formula used is: \( M_P = F_M \times F_R \times F_D \).
- For the oil reserve multiple calculation, the formula used is: \( M_P = F_M \times F_R \times F_D \).
- For the oil cash flow multiple calculation, the formula used is: \( M_{CF} = F_R \times F_D \).
## Valuation Summary

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Unit</th>
<th>Multiple</th>
<th>Value (SMM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Oil Production</td>
<td>10,000</td>
<td>bbl/day</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Oil Reserves</td>
<td>36,500</td>
<td>Mbbl</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Oil Cash Flow</td>
<td>73,000</td>
<td>M$</td>
<td>5.5</td>
<td>6</td>
</tr>
<tr>
<td>Gas Production</td>
<td>10,000</td>
<td>Mcf/day</td>
<td>900</td>
<td>1,200</td>
</tr>
<tr>
<td>Gas Reserves</td>
<td>36,500</td>
<td>MMcf</td>
<td>0.25</td>
<td>0.3</td>
</tr>
<tr>
<td>Gas Cash Flow</td>
<td>1,450</td>
<td>M$</td>
<td>5.5</td>
<td>6</td>
</tr>
<tr>
<td>Total Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Reserves</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cash Flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Valuation Ranges

- **Production**
- **Reserves**
- **Cash Flow**

![Graph showing valuation ranges for production, reserves, and cash flow.](image-url)
• Even when considering R/P and margin, multiples analysis is still inexact because other variables impact value
• There is no substitute for a Discounted Cash Flow analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Lower Multiple</th>
<th>Higher Multiple</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upside</td>
<td></td>
<td>May have value</td>
<td>Workovers, recompletions, PUDs, PROBs, optimization</td>
</tr>
<tr>
<td>Product Mix</td>
<td>More “gassy”</td>
<td>More “oily”</td>
<td>On a 6:1 equivalent basis, an equivalent of oil has more value than an equivalent of gas</td>
</tr>
<tr>
<td>Reserve Mix</td>
<td>Less PDP</td>
<td></td>
<td>Non-producing reserves have lower value than PDP reserves</td>
</tr>
<tr>
<td>Margin</td>
<td>Decreasing</td>
<td>Increasing</td>
<td>Margin may not be constant</td>
</tr>
</tbody>
</table>
Multiples analysis is improved by considering not only the R/P ratio, but also the margin

Synthetic multiples closely reflect the value and character of market multiples

Cash Flow multiples are independent of margin and product type

For a given initial production rate, an exponential decline profile has greater synthetic value than a hyperbolic decline profile

Variables other than R/P and margin, such as variable margin, product mix, reserves category mix, and upside, can have a significant effect on realized multiple

Equations to calculate production, reserves, and cash flow multiples as a function of R/P, margin, and discount rate are presented
Thank You !