KIMMERIDGE Energy

All-in-One Economic Analysis – An Update and Expansion on the Recycle Ratio

The oil and gas exploration and production business is inherently simple: find hydrocarbons cheaply and generate a high cash margin. In this piece, we will walk through how the recycle ratio embodies this fundamental claim and how it directly relates to measurements of asset value. We will then use the recycle ratios of 78 publicly-listed U.S. E&Ps to generate the U.S. cost curve, which can be used to measure industry performance in aggregate and as a benchmark for an operating team's performance.

The current U.S. cost curve shows that 71% of the companies in the sample, representing 74% of U.S. production in 2016, generated an average recycle ratio below 100% across their respective assets, illustrating recent industry underperformance. Companies at the front end of the cost curve have outperformed those at the back end (as well as the benchmark) in the public markets over the period analyzed, highlighting how performance along this dimension translates directly into shareholder value.

Finally, we will show how the recycle ratio can be used throughout the investment cycle in both pre-entry screening and post-entry operating performance measurement.

Introduction – A Review of the Recycle Ratio[1]

Broadly, E&P asset value (as it applies to ***unconventional*** assets) can be described as:

Asset Value = [NPV/well] x [# of wells] x [Repeatability]

The number of wells is driven by the areal extent of the acreage position, the net ownership interest (or density of the acreage ownership — higher net interest means more "net wells" per gross well drilled), well spacing, and the number of intervals through the vertical column. Repeatability represents both the repeatability across the areal extent of the acreage position and vertically through the various targeted intervals within the position.[2] When taken together, NPV/well and the number of wells can be collapsed to an asset NPV. We can then use the recycle ratio to approximate NPV, which is the subject of this piece.

At a high level, the recycle ratio equals operating cash flow per barrel divided by the proved developed finding and development cost, i.e., how much cash a barrel yields versus how much cash it costs to obtain or replace that barrel. It is a measure of capital efficiency that embodies return on investment (ROI).

How is the Proved Developed Recycle Ratio (PDRR) an approximation of NPV?

$$\text{PDRR} = \frac{\text{Operating Cash Flow (\$/BOE)}}{\text{Proved Developed F\&D (\$/BOE)}}$$

$$\text{PD F\&D} = \frac{\text{Drill \& Complete Capex}}{\text{Organic Proved Developed Reserve Adds}}$$

The denominator of PD F&D, organic PD reserve adds, is simply the EUR when viewed on a single-well basis. "De-unitizing" the above PDRR formula, then, by multiplying the numerator and denominator by EUR gives the total cash flow to be realized from the well in the numerator and the capex spent on the well in the denominator, or an undiscounted cash-on-cash multiple. NPV differs by summing the *discounted* cash flows and subtracting out the initial capex. NPV and recycle ratio are directly correlated, but two wells with the same recycle ratio could yield varying NPVs if one well returns the capital sooner thanks to a type curve with more flush production up front and less production in the tail.

[1] This is an update and expansion on our previous piece, "Why Winners Win" (October 2013).
[2] We have explored the concept of repeatability in our previous piece, "The Best of the Best" (September 2015); expect an update to that piece in the coming months.

The numerator of the recycle ratio, operating cash flow per barrel, is determined primarily by the following factors[3]:

1. Benchmark commodity prices and relative product split (oil/NGLs/gas)
2. Local differentials to the benchmark
3. Royalty rates (its inverse being NRI – net revenue interest)
4. Operating costs (LOE – lease operating expenses)
5. Production taxes
6. Corporate overhead, or cash G&A

The absolute level of cash flow per barrel will be driven primarily by the benchmark commodity price (outside an operator's control) and the commodity split, which is driven primarily by geology (inside an operator's control). However, while in the present commodity price environment a gas player will have a lower cash flow per barrel of oil equivalent (boe), our goal is not to analyze cash flow per boe in a vacuum but relative to F&D cost, which will be lower for gassy assets than for oil, and the overall framework will apply in a commodity-neutral fashion.

The primary sources of ***meaningful*** variation in cash flow per boe between operators are LOE and G&A. However, while it is incumbent upon an operator to work to optimize these metrics, the ultimate spread in operating cash flow per barrel between operators is not the primary driver of the overall differences in the recycle ratio. Figure 1 highlights this spread.

Figure 1: 3-yr (2014-2016) Operating Cash Flow per Boe (Source: Kimmeridge analysis of public 10K filings)

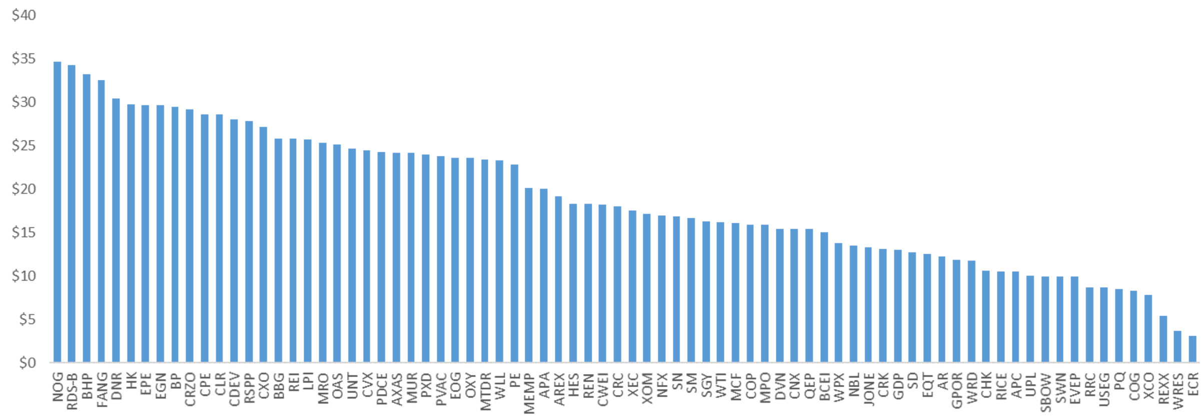


Figure 1 shows operating cash flow per barrel of oil equivalent by operator. The total spread between minimum and maximum is $31.53/boe (median of $17.77/boe) and the interquartile range (IQR – a measure of statistical dispersion) between the first and third quartiles is $12.60/boe.

[3] One additional factor that can impact operating cash flow is how a company manages its hedge book, but we have not addressed its impact in this analysis because how well or poorly a company does this is divorced from its operating performance and may not persist over time.

<u>The denominator of the recycle ratio</u> is PD F&D cost. This is given by the capital expenditure put into the ground through drilling and completion (fully loaded to include infrastructure, tie-in to product takeaway providers, etc.) divided by the proved developed reserves (in barrels) added. Stated more simply, how many dollars does it take to add a barrel of PDP reserves?[4]

On a single-well basis, the PD F&D distills into a well's capital expenditures divided by the estimated ultimate recovery (EUR) from the well. The two components of PD F&D differ in their relative contribution to the measure. Capital expenditures tend to converge within basins as successful drilling and completion strategies are more widely disseminated, service costs become more transparent, and differences are harder to sustain. Therefore, the ***main driver of differences in PD F&D between operators, between basins, and even between areas within a basin, is the EUR***, i.e., the total number of barrels a well will produce. Figure 2 shows the spread in PD F&D by operator and how this variation is much larger than that of operating cash flow per barrel.

Figure 2: 3-yr (2014-2016) Proved Developed F&D per Boe (ex. Negative F&Ds, capped at $100/boe) (Source: Kimmeridge analysis of public 10K filings)

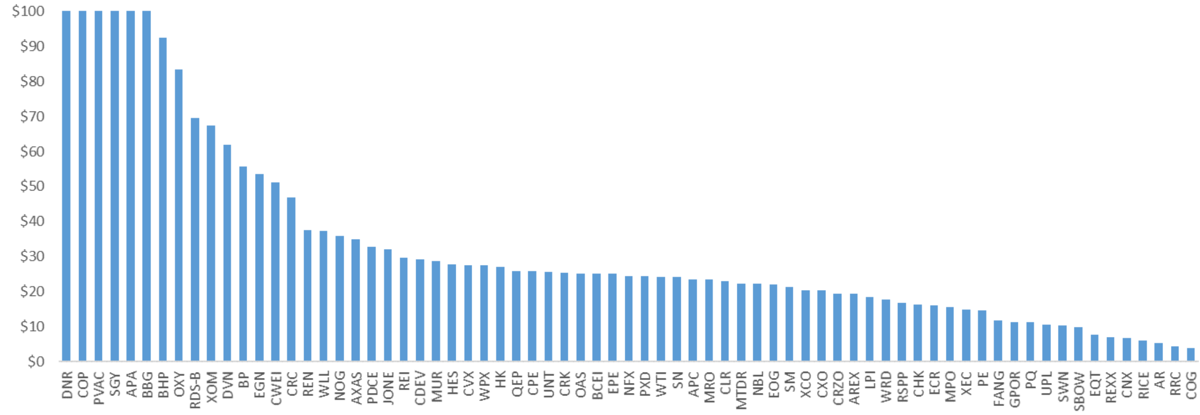


Figure 2 shows proved developed F&D cost per barrel of oil equivalent by operator, with the y axis truncated at $100/boe. The spread here is much wider at the extremes than operating cash flow per barrel, showing the outsized impact PD F&D has on the recycle ratio. The IQR in the above sample set is $19.57/boe (55% larger than operating cash flow per barrel). Companies with negative PD F&D were excluded from the sample set.

The differences in EUR are driven primarily by two factors, shown here in order of importance:

1. The underlying geology[5] (there must be recoverable barrels of hydrocarbon in place that can be exploited)
2. The method by which the operator exploits that geology (principally completion strategy)

Getting the geology right, or getting into the correct "petroleum zip code", is a function of both pre-investment geological analysis (identifying the core) and the ability to aggregate an acreage position of scale within the target area. It then falls to the operating team to deliver the full potential of the asset through proper drilling, completions, and production strategies.

[4] See Appendix for notes on the methodology by which reserves are included.

[5] We addressed how important it is to be in the core of an unconventional play and how widely the returns can vary between the core and the fringe in our previous piece, "Defining the Core of Shale Plays" (June 2012).

Key Takeaway:

The recycle ratio is the operating cash flow generated per barrel produced divided by the cost to add a barrel of reserves to replace it. The cost to add a replacement barrel is the proved developed finding and development cost (PD F&D), or the organic proved developed reserves added (EUR on a single-well basis) divided by the cost to add them (fully loaded drilling and completion cost). Taken together, the recycle ratio reflects whether you are generating sufficient cash flow to replace the barrels you are producing, and therefore can grow economically through internally generated cash flow.

The numerator of the proved developed recycle ratio, operating cash flow per barrel, is driven on an absolute level by the commodity price, a function of the macro environment, and such factors as the marginal cost of supply. The denominator of the recycle ratio, proved developed F&D cost, is the main driver of variation between operators. The constituent of this metric that delivers most of that variation between operators is the EUR, or proved reserves added per well. This factor is driven by bottom-up geological variables. The recycle ratio, then, is a measure of capital efficiency that embodies top-down macroeconomic phenomena and bottom-up geological phenomena to present an “all-in-one” view of economic performance.

Creating the U.S. Cost Curve

By calculating the proved developed recycle ratio for the U.S. assets of many publicly-listed U.S. E&Ps, we can generate the U.S. cost curve, showing how much of the United States' oil and gas production is generating enough cash flow to replace itself (and the proportion of operators that can grow within cash flow, see Figure 3). Each bar represents a different company, with the width of the bar representing its 2016 average daily U.S. production and the height of the bar representing its 2014-2016 3-year U.S. proved developed recycle ratio[6].

Figure 3: End-of-Year 2016 U.S. Cost Curve (Source: Kimmeridge analysis of public 10K filings)

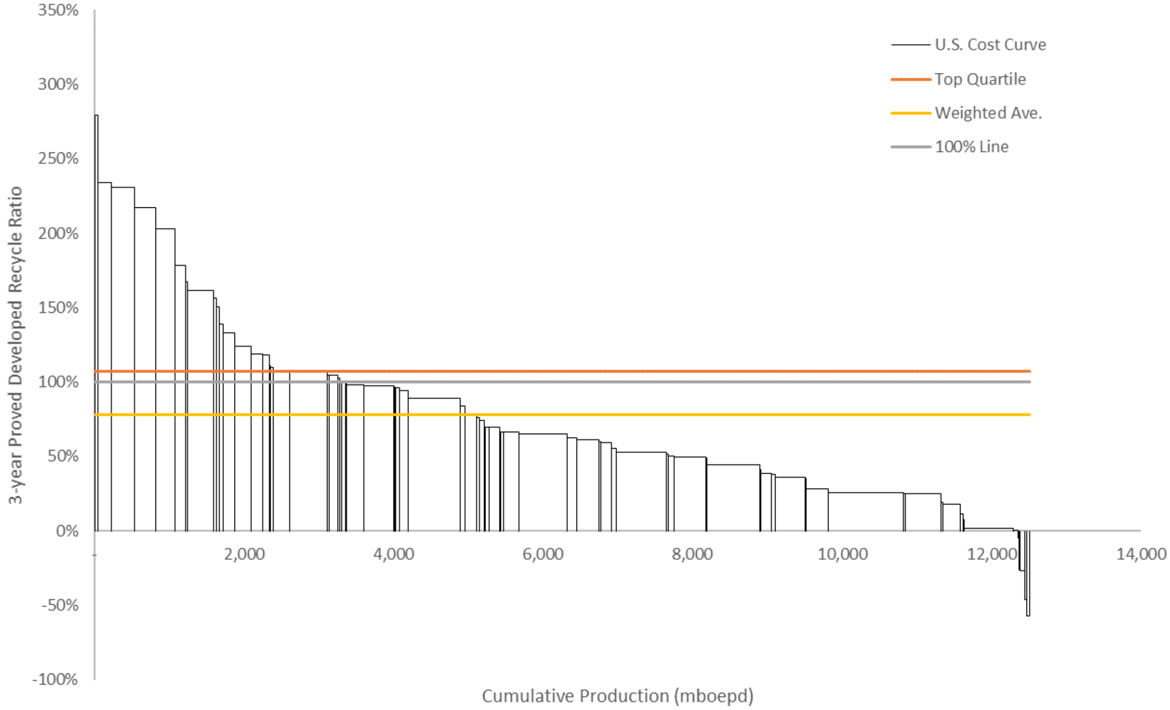


Figure 3 shows the U.S. cost curve: companies ranked by three-year proved developed recycle ratios, showing how much of the U.S. production is generating enough cash to replace itself. The width of the bars depicts the 2016 average daily production from a company; the height of the bars is the three-year (2014-2016) recycle ratio. There are 78 U.S. public E&Ps in the sample, representing a cumulative 12.5 mmboe per day of production, or 60% of the roughly 21 mmboe per day produced in the U.S. in 2016. Most of the production not included in the cost curve is from 1,000+ private oil and gas companies in the U.S., for which this information is not publicly available.

There are several phenomena that are interesting to address when looking at this aggregated view of sector economic performance, including the number of companies and share of U.S. production that is producing sub-economically, the relative commodity neutrality of the analysis, and the relative outperformance from companies at the front end. We will address each of these in turn.

In this three-year proved developed recycle ratio analysis, 55 of the 78 companies in the sample (71%) have a recycle ratio less than 100%, meaning they are generating less cash per barrel than it costs to replace that barrel. Put another way, they either must grow sub-economically or shrink. This sub-100% recycle ratio subset represents 9.2 million boe per day, or 74% of the total production

[6] See Appendix for notes on the methodology behind the creation of the U.S. cost curve.

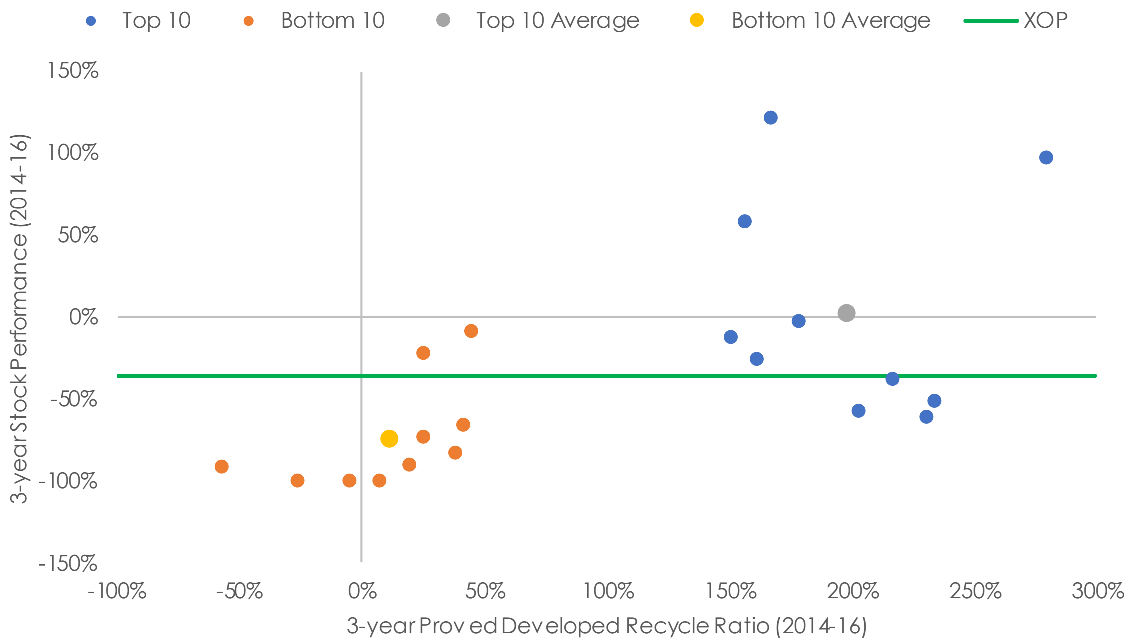
in the sample set. If scaled to the total U.S. production base, assuming the remaining U.S. production adheres to this sample set, it implies over 15 million barrels of oil equivalent per day of U.S. production cannot fund its own replacement.

Another interesting output, and one touched on earlier, is how the analysis is commodity neutral. Of the top 12 names in the 2014-2016 three-year cost curve, there are six Appalachian (Marcellus/Utica) pure plays, almost exclusively gas, as well as five Permian Basin and one Eagle Ford name, primarily oily. To reiterate what was previously discussed, the ratio does not analyze unit economics (cash flow per barrel), well performance, or F&D on a standalone basis. It is used to look holistically at whether invested dollars are generating a cash return.

Companies at the front end of the cost curve tend to deliver outperformance in the public markets relative to companies at the back end of the cost curve. This is expected but serves to provide a tangible example of how peer-leading performance along the recycle ratio dimension translates into superior returns for an investor.

A simple comparison of the 10 names at the front of the cost curve to the 10 names at the back of the curve on share price performance serves to quantify this outperformance[7]. The three-year change in share price (2014 – 2016, using adjusted closing prices that account for share splits and dividends) of the top 10 names was 3% on average, while the return for the bottom 10 names was -73% on average. For reference, the return on the XOP (SPDR S&P Exploration & Production ETF) over the same period was -36%. The top 10 names outperformed the benchmark and the bottom 10 underperformed the benchmark. Figure 4 shows a graphical distribution of the share price performance relative to the recycle ratio and against the XOP benchmark.

Figure 4: 2014-2016 Share Price Returns vs. Recycle Ratio for Top 10 and Bottom 10 Names on U.S. Cost Curve (Source: Yahoo! Finance and Kimmeridge)



[7] See Appendix for notes on the methodology behind this share price performance comparison and further detail on the analysis.

Key Takeaway:

We ranked companies by the recycle ratio to develop the U.S. cost curve, which shows the proportion of total U.S. production that is generating enough cash flow to replace itself. We saw that very little of U.S. production is currently economic, with only 29% of companies and 26% of production exhibiting recycle ratios greater than 100%. Notably, the 12 companies at the front of the cost curve are represented by six gassy names and six oily names, suggesting that the analysis is commodity neutral in the current environment. Finally, we observed that companies at the front of the cost curve have outperformed in the public markets relative to the XOP benchmark, while the companies at the back of the cost curve have underperformed.

Utilizing the U.S. Cost Curve in Pre-Investment Screening

One way to utilize the cost curve and recycle ratio in pre-investment screening is to conduct a "smell test" on results that would have to be attained for an asset to be at the front of the cost curve. We can walk through these relatively straightforward steps below:

1. Pick a recycle ratio hurdle. We would typically look at something like the top quartile of the U.S. cost curve (in the present case, that would be 107%), or a more aggressive target like 200% (being able to replace each barrel of production with two barrels of PDP reserves).
2. In each area, you can typically drill down to an expected cash flow per barrel that will not vary much between operators (as explored earlier):
    a. Assume a commodity price.
    b. Net out the royalty. Royalty rates converge in a basin and are known by anybody looking to lease acreage.
    c. Subtract out the production taxes. These vary by state and sometimes by commodity (oil or gas), but are knowable pre-investment.
    d. Subtract out operating costs. These include lease operating expenses, gathering/processing/transportation costs, and any other costs of production that come out after the royalty and taxes. For instance, royalties and taxes are not paid on the benchmark price but on the local price for which the commodity is purchased from the wellhead, so product differentials are not a production expense.
    e. Subtract out cash G&A. The organization will know its own G&A expense and should be able to allocate corporate overhead appropriately to production.
    f. This will yield the operating cash flow per barrel.
3. Given the cash flow per barrel and the recycle ratio target, or hurdle, you can engage in the process of assuming an EUR (one can utilize offset well results when available), and solving for what D&C capex number you would need to achieve. Is that number achievable? How far away is it currently? Alternatively, you could assume a capex number (perhaps by utilizing wells of similar depths/lengths in other areas) and solve for the EUR. Doing this on both sides provides a lens into how economic a play is currently or how far away it is from becoming economic. It also provides a way to compare plays to each other to see which ones have more believable, or attainable, EUR and capex targets.

Table 1 shows this process for a few of the currently popular unconventional basins. The inputs are intended to be merely illustrative; the exercise is merely meant as a framework for looking at the business. Within each of these basins, performance can vary widely, depending on whether you are in core vs. fringe acreage, where you are relative to the oil/condensate/gas windows, which intervals you are targeting, and what type of wells you are drilling (e.g. single-section vs. extended-reach laterals). When conducting this type of smell test internally, one would look at a more specific sample set relative to geographic location, geological target, and well type, among other factors. See the Appendix for some further notes on the methodology here regarding dealing with publicly available information.

Table 1: Using the Recycle Ratio to Understand Performance Targets by Basin (Source: Kimmeridge)

	Delaware Permian	Powder River	DJ - Niobrara	Eagle Ford	SCOOP STACK
Oil price	50.00	50.00	50.00	50.00	50.00
Oil differential	(2.00)	(5.00)	(4.00)	(2.00)	(2.00)
Oil realized	48.00	45.00	46.00	48.00	48.00
Gas price	3.00	3.00	3.00	3.00	3.00
Gas differential	(0.25)	(0.50)	(0.50)	(0.25)	(0.25)
Gas realized	2.75	2.50	2.50	2.75	2.75
Ngl realized	18.00	15.00	15.00	18.00	18.00
% Oil	50%	70%	40%	50%	60%
% Gas	20%	20%	20%	20%	30%
% Ngl	30%	10%	40%	30%	10%
Blended realized	32.70	36.00	27.40	32.70	35.55
Royalty	25.0%	15.0%	25.0%	25.0%	20.0%
Production tax	6.1%	6.0%	6.8%	6.1%	3.3%
Operating costs	6.00	8.00	5.00	9.00	7.00
Cash G&A	4.00	4.00	4.00	4.00	4.00
Operating CF/boe	**13.04**	**16.76**	**10.15**	**10.04**	**16.50**
Target recycle ratio	200%	200%	200%	200%	200%
If well costs are:	8.0	9.0	4.5	5.0	8.0
EUR needs to be:	1,227	1,074	886	996	970
If EUR is:	850	600	350	600	650
Well cost needs to be:	5.5	5.0	1.8	3.0	5.4

Table 1 compares some popular unconventional basins by what you would need to believe on well costs and EURs if you were targeting a certain recycle ratio; inputs are merely illustrative.

Key Takeaway:

The recycle ratio can be used as a framework to compare assets against each other and conduct pre-investment "smell tests" to develop a view on the economic potential of a play. By figuring unit economics (cash flow per barrel), you can fix the EUR and calculate what capex you would need to achieve a recycle ratio target, or fix the capex and see what EUR you would need to achieve a recycle ratio target. Comparing these outputs to where costs and well results are currently will illustrate where the asset currently sits on the cost curve and how much the operating team needs to improve performance to move it toward the front of the cost curve.

Utilizing the U.S. Cost Curve in Post-Investment Performance Targeting

Similar to the pre-investment recycle ratio framework, this simple heuristic can be used as a powerful key performance indicator (KPI) for targeting within the operating team. Unlike NPV and IRR calculations that can be cumbersome (or at least require some formal calculation), the recycle ratio is a simple framework that can be understood and communicated through an operating team and tracked fairly easily over time.

As a first step, oil and gas production unit economics must be understood; you must know how much cash you are generating per barrel produced. While this does not tend to be the differentiating factor among various operating teams, it is still incumbent upon a manager to seek to optimize the asset's product differentials, operating expenses, gathering and processing expenses, and corporate overhead (on a per-barrel basis).

Once the unit economics (cash flow per barrel) are understood, one can undertake the same exercise of determining relative asset performance. Given fully-loaded capital expenditures and well performance, where does the recycle ratio against the entire U.S. cost curve (e.g., top quartile), competitors in the basin[8], and/or an internal hurdle? This heuristic is useful as a KPI because of its simplicity in calculation — it can be done in your head or on a napkin — and its intuitiveness to the team.

A simple example of this is the decision to move from one-section horizontals (~4,500 lateral feet) to two-section horizontals (~10,000 lateral feet). Let us quickly walk through the numbers and see how viewing the trade-offs through the recycle ratio lens impacts the ultimate investment decision.

Table 2 (at right, next page) shows a comparison of the two well types. Assuming you can fit four wells per section in a horizon, you are effectively at "160-acre spacing" (a 640-acre section split into four drilling units). A two-section horizontal would simply double this. Loading the land spend onto the well at the same $/acre number yields precisely double the acreage spend for double the acreage. However, on drilling the cost growth is not linear. Drilling the actual lateral is typically one of the most efficient parts of the drilling operation, and it may only take an extra two or three days to drill an extra 5,000 feet or so. In the example, we have assumed an extra five days. The completion cost mostly scales linearly with the number of stages, which with constant stage spacing will scale linearly with lateral length. Infrastructure and tie-in costs will be largely

[8] A comparison with local competitors (in addition to your ranking on the entire cost curve) is a useful exercise to evaluate your "basin beta", or whether your performance is merely due to the underlying geology. Getting into the best "petroleum zip code" is a function of pre-investment geological/analytical work and the ability of the land group to get the position together. But getting results that outstrip your basin peers — or generating "basin alpha" — will be a function of the operating team delivering superior well performance per unit of cost.

unaffected by a well with a longer lateral, and any marginal changes can be assumed to be negligible for our purpose here.

You can see that the well cost for the two-section horizontal is 72% higher, given our assumptions here. However, we have not yet accounted for the increase in EUR. We have typically seen that EUR scales mostly linearly with lateral length, and in this example we have assumed an elasticity of EUR of 90% relative to lateral length (we have multiplied the one-section EUR by 90% of the ratio of two-section lateral feet to one-section lateral feet).

$$EUR_2 = EUR_1 * [0.90 * (10{,}000 / 4{,}500)]$$

Dividing the total well cost by the EUR gives our PD F&D cost, and dividing our operating cash flow per barrel (the same in either case) by the PD F&D gives us the single-well recycle ratio. In this case, we see that it is accretive to the recycle ratio to undertake two-section horizontals.

Table 2: Extended Reach Lateral Impact on Recycle Ratio

	1-sxn	2-sxn	
Lateral length	4,500	10,000	feet
Well density	4	4	wells/sxn
Acres / well	160	320	acres
Cost / acre	10,000	10,000	$
Land cost / well	1,600	3,200	$000s
Days to drill	25	30	days
Drilling cost / day	75,000	75,000	$
Drilling cost	1,875	2,250	$000s
Frac stage spacing	200	200	ft
Frac stages	22	50	stages
Completion cost / stg	75,000	75,000	$
Completion cost	1,650	3,750	$000s
Infrastructure/tie-in	500	500	$000s
Total capital cost	5,625	9,700	$000s
EUR	900	1,800	mboe
PD F&D	6.25	5.39	$/boe
Op Cash Flow / boe	15.00	15.00	$/boe
PD Recycle Ratio	240%	278%	

This KPI guides the operating team along what we consider to be its core functionality: to move the asset to the front of the cost curve. While, again, part of this is maximizing the unit economics, most of the performance enhancement along this dimension is going to come from the paired targets of improving well results (measured by EURs) and decreasing fully-loaded well costs. In this framework, traditional oil and gas operating KPIs like footage drilled per period, frac stages put away per period, wells completed, average well costs, or any other operational measure ***are considered only with respect to their impact on the recycle ratio***. This helps to avoid the problem many organizations face (and arguably the crux of resolving any principal-agent problem) with optimizing toward whatever is measured, at the expense of something more ephemeral that is ultimately desired. One could argue that is exactly what we are doing here — targeting the recycle ratio as opposed to something more rigorous like the NPV of cash returns to the investor — but we aim to present the case that the proved developed recycle ratio is the more reasonable maximization of two sometimes opposing factors: ease of use and economic rationality.

Key Takeaway:

The recycle ratio can be used as a simple but powerful KPI against which an operating team can easily track its performance. As opposed to traditional operating metrics (footage drilled, wells completed, average well costs, etc.), the recycle ratio embodies cash-on-cash return and therefore is a closer approximation of the ultimate returns the team is trying to generate. As opposed to more financially rigorous metrics like NPV and IRR, the recycle ratio is simple to calculate and intuitive to understand all the way through the operating team, and is therefore a more useful heuristic by which to make and measure decisions.

Conclusions

The oil and gas business is inherently simple: find hydrocarbons cheaply and generate a high cash margin. We believe the proved developed recycle ratio presents a simple yet effective heuristic that can be used to understand whether you are generating sufficient cash flow to replace the barrels you are producing, and therefore can grow economically through internally generated cashflow.

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Finally, the recycle ratio can be used as a simple but powerful KPI against which an operating team can easily track its performance. As opposed to traditional operating metrics (footage drilled, wells completed, average well costs, etc.), the recycle ratio embodies cash-on-cash return and therefore is a closer approximation of the ultimate returns the team is trying to generate. As opposed to more financially rigorous metrics like NPV and IRR, the recycle ratio is simple to calculate and intuitive to understand all the way through the operating team, and is therefore a more useful heuristic by which to make and measure decisions.

APPENDIX: METHODOLOGY

Two quick notes on reserves that are being excluded from consideration in calculating the recycle ratio:

1. We are not including proved undeveloped (PUD) reserves here because the capital to develop those reserves has not yet been deployed, and we are not including it in the numerator of the PD F&D calculation. Essentially, counting PUD reserves would be pulling the reserve additions ahead of the capital expenditure. PUDs will be included in the F&D when the capital has been deployed to drill them up and convert them to PDP.
2. We are not including acquired PD reserves (hence "organic" PD reserve adds) here because acquisition capital is not being included in the numerator. Typically, the PDP acquisition market is more efficient and acquiring those producing reserves at a significant discount to the cash flow per barrel they are generating is not as repeatable.

A few notes on the methodology underlying the creation of the three-year U.S. cost curve:

1. The reason to use three-year recycle ratios is to smooth out the impact of individual years, and there are a few reasons why using a single-year daily production number with a three-year recycle ratio is not necessarily a mismatch:
    a. The production is not coming solely from reserves added this year but is coming from (or drawing down) <u>all</u> the PDP reserves on the books (including the production from those PDP reserves added "this year").
    b. One might then argue you should take the recycle ratio looking all the way back, but that is not necessarily representative of where the company is right now. How is the company currently performing with respect to generating enough cash from its producing reserves to replace them?
    c. One-year numbers, especially in years with a drastic change in commodity price, can be skewed due to a period of adjustment between top line prices and costs. Using a three-year number averages some of this out, which allows us to look at how a company performs through the cycle.
    d. The choice of three years is admittedly arbitrary but one we think works well enough.
2. The cost curve presented only exhibits the U.S. segments of the individual companies in the sample set.
3. The sample set only includes publicly-listed E&Ps in the U.S. with reported data going back three years; i.e., there are no one-year or two-year numbers embedded in the curve from newer companies.

Notes on the relevance of publicly reported investor relations data for internal analysis:

Comparing BCEI's Public Performance Data with Actual Results (Source: Kimmeridge, IHS, public 10K and IR filings)

BCEI performance guidance	SRL	MRL	XRL
Lateral length (ft)	3-5,000	5-8,000	8-10,000
Producing wells	298	17	24
EUR (mboe - avg well)	194	230	306
EUR (mboe - best wells)	369	393	412
EUR (mboe - IR deck)	356	518*	680
Avg modeled EUR vs. IR	54%	44%	45%
Best modeled EUR vs. IR	104%	76%	61%
D&C from IR presentation	$2.90	$4.00*	$5.10

Note: All EURs on a 3-stream basis
*MRL EUR and capex 'guidance' is average of SRL and XRL

Corporate IR presentations tend to select the best well results and rarely show fully loaded capital expenditures. Actual drilling and completion costs are just a part of the cash spend to get oil and gas wells online. In addition, there is the cost of leasing the land (allocated to the well), field infrastructure (roads, pads, electricity, etc.), in-field gathering and takeaway infrastructure, water sourcing and disposal infrastructure, etc. Rarely, if ever, will the cost per well from an IR presentation multiplied by the number of wells drilled in a given period equal the total exploration and development capital expenditure on an audited public filing. This same consideration applies to well results. Taking an example from the DJ Basin, the table above compares actual well results to guided well results from Bonanza Creek Energy, showing that the actual well results came in far below what was indicated in their public materials. Simply taking the reserves booked in a year and dividing by the number of wells drilled will rarely, if ever, yield a number in line with the "IR-EUR". This highlights the challenge investors and analysts face when consuming corporate correspondence at face value. It is imperative when conducting this analysis to check the public comments against actual results obtained through state regulatory reporting agencies or third-party data service providers.

Public company share price performance analysis:

The top 10 names on the cost curve were all purely unconventional players. As the U.S. cost curve is meant to embody most of the publicly reported U.S. supply base, it includes all types of companies engaging in exploration and production. To provide a more sensible comparison to the front of the cost curve, we removed names at the back of the cost curve that did not have significant unconventional exposure. The bottom 10 names therefore represent the worst recycle ratio performers in the unconventional space.

The share prices were the adjusted closing prices (adjusted for splits and dividends) taken from Yahoo! Finance's historical price data. The averages for the top 10 and bottom 10 names are arithmetic averages of the returns for the individual names in the sample.

See the following table for the names included in the sample and the numbers used to calculate the returns. Yellow cells represent companies that went public during that year, so the share price listed is the adjusted closing price from their first day of trading. Red cells represent companies that filed under Chapter 11; investors that had owned equity in these companies from the beginning of 2014 would have been virtually wiped out.

Unconventional Names		Stock price (adjusted closing - Yahoo Finance)				Returns 2014-16	2016	2014-Today	YTD	2014-16
Ticker	Basin(s) / Asset(s)	BOY2014	BOY2016	EOY2016	10/24/2017	3-yr return	1-yr return	Total return	YTD return	PDRR
XOP	Benchmark Index	64.29	29.90	41.15	32.53	-36%	38%	-49%	-21%	
Top 10										
FANG	Permian	51.16	66.11	101.06	99.67	98%	53%	95%	-1%	279%
CNX	Appalachian	37.18	8.56	18.23	16.12	-51%	113%	-57%	-12%	234%
AR	Appalachian	60.98	22.68	23.65	18.96	-61%	4%	-69%	-20%	231%
COG	Appalachian	37.64	17.44	23.24	24.92	-38%	33%	-34%	7%	217%
RRC	Appalachian	80.82	25.63	34.27	18.59	-58%	34%	-77%	-46%	203%
RICE	Appalachian	21.90	11.03	21.35	28.36	-3%	94%	29%	33%	179%
RSPP	Permian	20.15	24.48	44.62	31.75	121%	82%	58%	-29%	167%
EQT	Appalachian	88.19	52.97	65.30	64.05	-26%	23%	-27%	-2%	162%
PE	Permian	22.20	18.47	35.24	24.05	59%	91%	8%	-32%	157%
CRZO	EagleFord, Permian	42.80	29.07	37.35	14.86	-13%	28%	-65%	-60%	151%
Total						3%	56%	-14%	-16%	198%
Bottom 10										
EVEP	All over U.S.	25.10	2.73	2.09	0.63	-92%	-23%	-97%	-70%	-58%
SD	MidCon MissLime	5.99	0.18	-	-	-100%	-100%	-100%	-22%	-27%
GDP	H'ville,EglFrd,TMS	16.21	0.28	-	-	-100%	-100%	-100%	-21%	-5%
PVAC	Eagle Ford	9.21	0.32	-	-	-100%	-100%	-100%	-19%	8%
ECR	Appalachian	25.75	1.86	2.67	2.19	-90%	44%	-91%	-18%	19%
DVN	Perm,SCPSTK,PRB	57.87	31.67	45.44	34.84	-21%	43%	-40%	-23%	25%
BBG	DJ	26.19	4.07	6.99	4.40	-73%	72%	-83%	-37%	25%
XCO	So.Tx,H'ville,Appal.	76.01	18.60	13.05	1.23	-83%	-30%	-98%	-91%	38%
JONE	SCOOPSTACK	14.54	3.78	5.00	1.29	-66%	32%	-91%	-74%	41%
APC	Multiple / Int'l	76.05	48.80	69.52	48.05	-9%	42%	-37%	-31%	45%
Total						-73%	-12%	-84%	-41%	11%

An interesting output of the analysis is that the top 10 names outperformed the benchmark and the bottom 10 names underperformed the benchmark for all the time slices. This includes year-to-date 2017 (as of 24 October 2017 data), which is out of sample for the recycle ratio inputs and calculations. See the table below for a summation of these results. The year-to-date numbers for the companies that filed under Chapter 11 are referencing the re-equitized entities that emerged from bankruptcy in 2016.

	2014-16	2016	2014-Today	YTD
Top 10	3%	56%	-14%	-16%
XOP	-36%	38%	-49%	-21%
Bottom 10	-73%	-12%	-84%	-41%

A final phenomenon to note is that in the bottom 10, an investor would have been exposed to three companies whose equity went to zero, and perhaps five of the other seven could potentially end up there (EVEP, ECR, BBG, XCO, JONE). In the top 10, none filed under Chapter 11 through the commodity price collapse.

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