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Enhancing Management Insight into Mergers & Acquisitions Using Probabilistic Financial Analysis

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Abstract

Between 2011 and 2022 greater than 50% of global E&P merger and acquisition (M&A) transactions destroyed shareholder value with only 25% generating approximately 60% of total excess returns, per a 2024 paper from McKinsey & Co.[1] Upgrading the financial analysis approach to provide better insights for M&A decision-making professionals is therefore increasingly important to enhance their probability of success. This paper analyzes the 2021 merger of Cabot Oil & Gas with Cimarex Energy (the Transaction) to understand the distinct advantages gained from applying a probabilistic approach to the financial analysis of mergers, acquisitions and divestitures. Traditional deterministic valuation and transaction analyses, which rely on a static set of assumptions, are compared to a probabilistic approach based on Monte Carlo simulation using a readily available Excel add-in. This paper reviews and utilizes the additional insights from the probabilistic output, generated from the input probability distribution functions and correlation coefficients chosen, unavailable from a traditional, deterministic financial approach. The probabilistic approach provides an enhanced transaction analysis process that produces the critical metrics company Boards and shareholders increasingly require in determining if a transaction should be undertaken. This paper highlights how a probabilistic approach to the M&A process: (i) is straightforward to implement; (ii) facilitates a greater use of real-world data; (iii) generates outcome probabilities for key transaction metrics unavailable with a deterministic approach; and (iv) provides unique risk insights into those transaction metrics. This probabilistic approach to the M&A process represents a significant, practical improvement to management's ability to evaluate specific transactions and enhance their likelihood of success.

Introduction

On May 24, 2021, Cabot Oil & Gas Corporation (Cabot) and Cimarex Energy Co. (Cimarex) announced a $17 billion, all-stock merger of equals whereby Cabot would issue 4.0146 of its own shares for each Cimarex share (the Exchange Ratio). Per the Joint Proxy Statement/Prospectus (Proxy Statement) filed with the Securities & Exchange Commission (SEC) on August 23, 2021, the Exchange Ratio was deemed ‘fair, from a financial point of view’ by Cabot's financial advisor, J.P. Morgan Securities LLC (JPM), and Cimarex's financial advisor, Tudor, Pickering, Holt & Co. (TPH), based on their respective deterministic

analyses.[2] This paper will review and compare these deterministic analyses to a probabilistic analysis based on publicly available data.

JPM and TPH (the Advisors) are industry-leading financial advisors with a wealth of experience and insight into undertaking a fairness opinion for a merger transaction of this type. The Advisors would have undertaken a range of different analyses to support their conclusions regarding the fairness of the Transaction. This paper does not question their analysis or conclusions. Instead, it seeks to analyze the deterministic data used by the Advisors to highlight how a probabilistic approach can significantly upgrade the valuation exercise and enhance the M&A analysis process. New methods and insights are also introduced to facilitate a better understanding of shareholder risk and the importance of dynamic sensitivity analyses to identifying the critical post-transaction drivers of value accretion.

Despite the industry's need to increase its level of M&A success, no relevant papers were identified in a search for ‘probabilistic M&A’ on OnePetro; the online library of technical literature for the oil and gas industry containing over 1.3 million documents. A search for ‘probabilistic finance’ identified 548 journal articles and proceedings papers, primarily related to reserves analysis and real option valuation. Another 692 articles and papers were found in a search for ‘mergers and acquisitions’, of which none incorporated a probabilistic approach. Accordingly, the authors trust this paper will act as a catalyst for other finance and M&A practitioners to further develop a probabilistic approach to help upgrade M&A from an ‘art’ to a ‘science’; an approach that will bring a quantitative, objective discipline to improve the probability of transaction success in support of Board, management and shareholder value-accretion goals.

Probabilistic Approach Overview

A probabilistic approach to financial modeling simply means that instead of including one input value per cell in an Excel model, and then running multiple iterations based on selectively changing the single input cells, as done with a deterministic approach, a specific range of values is incorporated into a particular cell for an input that experiences variability. A probabilistic model therefore generates a range of output values, for a specific calculation in a particular cell, defined by their associated frequency of occurrence instead of just one value with no sense for its particular probability. The probabilistic approach is achieved through using an Excel add-in software package of which several time-tested products are readily available. These Excel add-ins are: (i) easy to learn and use; (ii) fully integrated with all Excel functions; (iii) no longer a ‘black box’ given their wide application to-date; and (iv) able to generate a multitude of quantitative metrics, graphs and charts unavailable with a deterministic approach.

Importantly, a probabilistic approach allows users to integrate significantly more commercial data into their financial models using both probability distribution and time-series functions to best incorporate the variability of the actual inputs. These probabilistic input distributions can be estimated from historical data or through choosing the likely input range based on commercial experience. Unlike a deterministic analysis, the user does not have to decide which individual data points to include to best represent the scenario being considered or run multiple scenarios to mimic the functionality of the Monte Carlo simulation underpinning a probabilistic approach. Including all the data in one probabilistic model rather than in a range of deterministic models: (i) incorporates unique insights from real-world data otherwise missed; (ii) provides greater insight into the variability of the output metrics calculated; (iii) reduces the risk of mistakes; and (iv) significantly reduces modeling cycle time and cost for the user.

A probabilistic approach also allows users to define the commercial relationship between the input variables in a way not fully possible with a deterministic model. Most deterministic models assume the inputs are independent of each other (i.e. their correlation is 0) and/or they are linear. This primarily reflects the inability to incorporate correlation coefficients into a deterministic model. With a probabilistic model, the correlations between input variables, or copulas for non-linear relationships, can be included to ensure each iteration only includes data that is meaningful across the range of inputs. Copulas are critical where

non-linearity exits between input variables, as experienced in the energy industry, to ensure the output values properly reflect the commercial reality of the metric being calculated. This also ensures the output range is more trustworthy, which enhances the risk insights provided by the model.

When the probabilistic model is run, the underlying Monte Carlo simulation undertakes many iterations (100s per second) utilizing the Excel functions, the data in the input distribution functions, and the correlations defined for the input variables. This results in an output graph, a histogram, showing the range of output values and their frequency of occurring. Based on the output distribution, always shown in red in this paper, the probability range of a specific value can then be calculated per Figure 1 below. The total probability range starts at P0 at the left of the graph and increases to P100 at the right of the graph, on the x-axis.

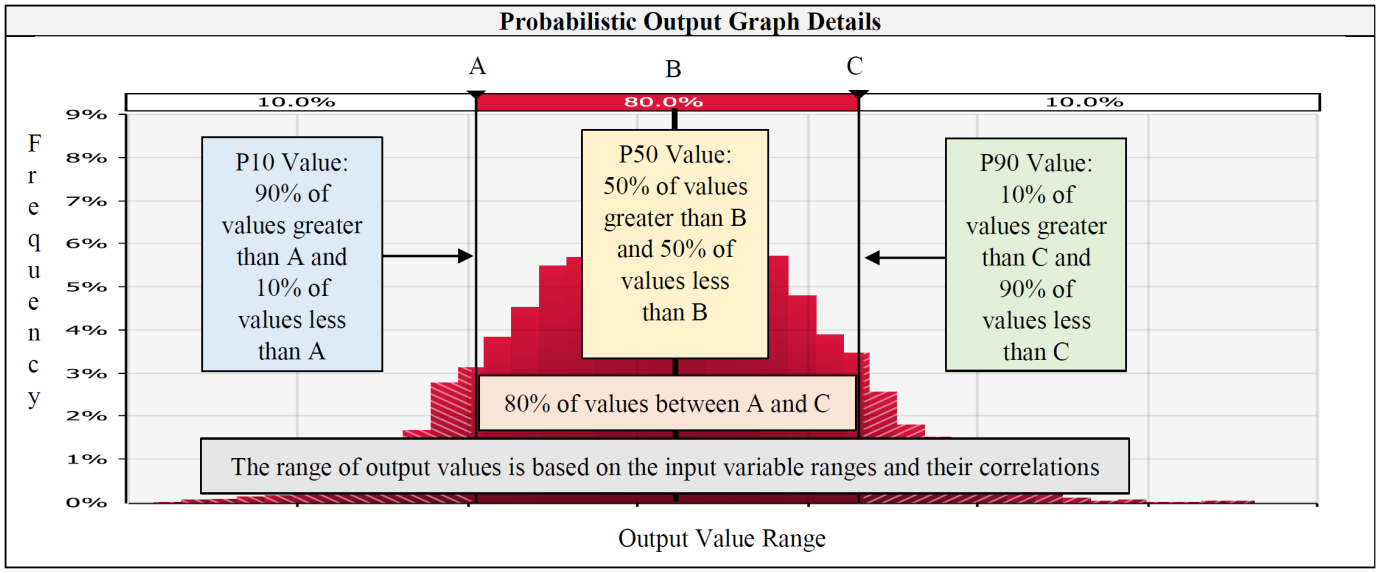

Figure 1—Probabilistic output graph introduction.

Rather than manually creating the output sensitivity analysis through 'rules-of-thumb' or 'guesstimates', where inputs are often changed by arbitrary amounts such as +/– 10% with limited reference to their actual variability, a probabilistic software does this automatically given the input probability functions utilized, thus providing greater insight into the commercial variability of the output metric calculated. A probabilistic sensitivity analysis also provides users with insights into the output variability, through the application of risk metrics such as the P90/P10 ratio (P90 value divided by the P10 value), which are not available in a deterministic analysis, significantly enhancing the usefulness of its risk analysis and decision-making insights. Importantly, the speed of the Monte Carlo simulation process in today's software means a probabilistic model can be run far more quickly than a deterministic model to generate the orders-of-magnitude more data required to highlight the real-world variability of the specific output generated.

Finally, it is important to note that the energy industry already uses, and intrinsically understands the benefits of, a probabilistic approach. Whether used by geoscientists or engineers to understand and manage the risks of exploration, development and production, or by finance professionals to evaluate real options[3] and model enhanced portfolio optimization, a probabilistic approach is already part of the industry knowledge base and lexicon. This paper seeks to specifically highlight how this expertise can be further leveraged across the M&A function, given the significant value-creation upside possible through increasing the probability of transaction success, as one valuable application. A probabilistic approach can also be applied across the broader finance function, whether for budgeting, valuation, investment, capital raising and/or risk analysis, based on the approach outlined below.

Transaction Analysis

Before undertaking a probabilistic analysis of the Transaction, it is important to first understand the deterministic valuation approach used by the Advisors. It is by understanding the qualitative and subjective nature of the M&A process today, and its resulting limitations, that we can identify where improvements can be made through utilizing updated methodologies and technologies. M&A practitioners, almost exclusively, use a deterministic approach in undertaking different valuation analyses to calculate a per share value range for acquirors or targets in an M&A transaction. These valuation ranges then form the basis for the fairness opinions provided to the Boards of acquiring and target companies, which authenticate a transaction as being 'fair, from a financial point of view'.

The deterministic M&A valuation methodologies underlying the fairness opinions, and the assumptions driving the resultant value ranges, from each Advisor, are set out per Table 1 below. Differences in methodology and assumptions are highlighted in red. In terms of the abbreviations, EBITDAX is defined as earnings before interest, taxes, depreciation, amortization and exploration expense, while OCF (Operating Cash Flow) is defined as net income plus depreciation, amortization, exploration expense and deferred taxes.

Table 1—Transaction assumptions used by JPM and TPH for deterministic valuation analyses.

Deterministic Financial Valuation Assumptions		
	JPM	**TPH**
Commodity Price Forecast	Single annual price case: 2021-2025	Three different annual price cases: 2021-2025
Production Projections	Single annual production case	Three different annual production cases
EBITDAX Projections	Single annual EBITDAX case	Nine different annual EBITDAX cases
Capital Expense Projections	Single annual Capex case	Three different annual Capex cases
Deterministic Financial Valuation Methodologies		
	JPM	**TPH**
Cabot Trading Multiples	4.50x-7.00x for 2021E EBITDAX 5.25x-7.00x for 2022E EBITDA*X* 3.00x-7.00x for 2021E OCF 3.25x-7.00x for 2022E OCF	6.00x-7.50x for 2021E EBITDAX 6.00x-7.50x for 2022E EBITDAX $17,500-$22,500 boe/d for 2021E Production $17,500-$22,500 boe/d for 2022E Production
Cimarex Trading Multiples	5.00x-6.50x for 2021E EBITDAX 4.75x-5.75x for 2022E EBITDAX 3.75x-5.25x for 2021E OCF 3.75x-5.00x for 2022E OCF	4.75x-5.75x for 2021E EBITDAX 4.50x-5.50x for 2022E EBITDAX $35,000-$45,000 boe/d for 2021E Production $32,500-$42,500 boe/d for 2022E Production
DCF Analysis	Terminal values based on perpetual growth rate for Cabot (1.5%-2.5%) and Cimarex (2.0%-3.0%). Cabot discount rate (8.25%-9.25%) and Cimarex (9.50%-10.50%)	Terminal values based on multiple of 2025 EBITDAX for Cabot (6.00x-7.50x) and Cimarex (4.50x-5.50x). Cabot discount rate (6.50%-8.00%) and Cimarex (8.00%-9.75%)
NAV Analysis	Method not used	Cabot discount rate (6.50%-8.00%) and Cimarex (8.00%-9.75%)

Three separate valuation methodologies were used by the Advisors; comparable trading multiples, a discounted cash flow valuation using a terminal value (DCF), and a net asset valuation based on the reserve profile (NAV). The DCF and NAV valuation analyses were both based on the sum of the discounted cash flows; the DCF valuation was based on 5 years of cash flows and a 2025 terminal value whereas the NAV valuation was based on cash flows from the economic life of the proved reserves with no terminal value. For both the Cabot and Cimarex valuations, JPM relied on a single Cabot management projection case and single commodity price forecast, while TPH relied on three Cimarex management projection cases and three different commodity price forecasts.

In reviewing the different trading multiple and financial model assumptions used by the Advisors, for both Cabot and Cimarex, certain questions must be asked. How do Boards and shareholders know which assumptions are reliable? How well do random, single-value estimates of input variables accurately calculate the likely range of values and what is the likelihood (probability) of their occurrence? How do they know

whether the resulting outputs are an accurate representation of the intrinsic per share value range for each company? How do they know the Advisors are not subjectively choosing input values to achieve desired Transaction metrics, to ensure the transaction closes and they receive their 'success fee', given the lack of consistency between most of the input variables?

As can be seen in the table above, the differences in methodology and assumptions far outweigh the similarities yet both Advisors relied on the same information from public and private data sets. From a trading multiple perspective, JPM and TPH used the same comparable companies for Cabot (EQT Corporation, Range Resources, CNX Resources, Southwestern Energy, Antero Resources). Yet different multiple ranges were chosen for the 2021E EBITDAX and 2022E EBITDAX values, with the low end of the ranges differing by 15% to 20%. With respect to Cimarex, a different selection of comparable companies was made by JPM (Continental Resources, Devon Energy, Diamondback Energy, Magnolia Oil & Gas) and TPH (Continental Resources, Devon Energy, Diamondback Energy, Callon Petroleum, Marathon Oil, Ovintiv, PDC Energy) resulting in different trading multiple ranges, though the ranges were now more similar. Without knowledge of the assumptions behind the difference in trading multiples chosen, or why they were applied to different values for 2021E and 2022E EBITDAX by each Advisor, it was not possible to fully understand what the implied value ranges meant or how much they could be relied upon for the Exchange Ratio calculation. JPM also used operating cash flow-based multiples in their analysis while TPH used production-based multiples, both of which resulted in different value ranges for both Cabot and Cimarex.

From a DCF perspective, the Advisors used different approaches to calculate the financial inputs (commodity prices, production levels, operating and capital costs), the terminal value and the discount rates per Appendix 2a and 3a below, for Cabot and Cimarex respectively. This use of different, unreconciled data also made it difficult to undertake a direct comparison between the DCF analyses and the resultant Exchange Ratio, which is reflected in the variance of the Exchange Ratio ranges versus the Transaction ratio of 4.0146. The uncertainty associated with the input values equally applied to the NAV valuation analysis, which was only used by TPH; as this is based on the economic life of the proved reserves, it is an important analysis to understand the value floor for an E&P company.

The other concern with the JPM and TPH analyses related to the likelihood of occurrence of the different values within the estimated ranges. While the methodologies and metrics were industry standard, how could the value ranges be trusted if their probability of occurrence was not known? This especially applies to the DCF and NAV analyses given the number of inputs included in their calculation (trading multiple ranges are inherently subjective), especially given how different they were for each Advisor. Where single-point estimates are used for these input values, how can the output value be trusted; it is merely one potential value in a wide range of potential output values whose probability is unknown. These significant limitations further encourage the important question; is there a better approach to make the valuation process more transparent and quantitatively insightful?

Based on the assumptions discussed above, the deterministic per share value ranges for each Advisor are set out per Table 2 below. The focus of this paper is to review the deterministic value ranges, as calculated for each company by the Advisors, and how they compare to the value ranges calculated using a probabilistic approach.

Table 2—Valuation ranges per JPM and TPH analyses. Ranges are based on the low/high values from the different valuation methodologies.

Methodology	Cabot ($/Share)		Cimarex ($/Share)	
	JPM	TPH	JPM	TPH
Trading Multiple Valuation	$7.25 – $19.75	$13.97 – $23.33	$51.75 – $77.50	$50.13 – $94.28
Discounted Cash Flow Valuation - Terminal Value (DCF)	$14.50 – $19.75	$14.97 – $24.54	$61.75 – $82.75	$67.78 – $111.51
Discounted Cash Flow Valuation - Reserves (NAV)	Not Calculated	$15.93 – $37.52	Not Calculated	$64.44 – $113.86
Deterministic Value Range	**$7.25 – $19.75**	**$13.97 – $37.52**	**$51.75 – $82.75**	**$50.13 – $113.86**

The absence of associated probabilistic distributions is a critical limitation of the value ranges estimated for each company. For Cabot, the low end of the JPM range is half the value of the low end of the TPH range, while the TPH high end value is almost twice that of JPM. How can there be so much difference if both Advisors are using the same information? For Cimarex, the value ranges are closer though TPH's high end values are 20% to 35% higher than those of JPM. Given this disparity, the question remains. How can we interpret this wide range of values, and the resultant Exchange Ratio, without knowing the probability of their occurrence and where the respective values fit on an objective, probabilistic range?

Probabilistic Model Inputs

The probabilistic NAV valuation model and analysis underlying this paper utilizes publicly available data from the Cabot and Cimarex 2020 10-K and March 2021 10-Q filings with the SEC.[4,5,6,7] An NAV model was chosen as the most appropriate comparison given its focus on the proved reserves and production profile for each company. From the proved reserves and related PV-10 value (the present value of annual after-tax cash flows from proved reserves production, discounted at 10%) in the 10-K, an analysis for each company was undertaken to calculate future annual production, price differentials, operating costs and capital costs. In addition to the proved reserves, incremental production out to 2025, based on management's forward-looking statements for wells drilled, was also included. The distribution profile for each input was chosen based on historical ranges. The copulas chosen were based on commercially estimated values. Synergies from the Transaction were not included in the valuation model. The JPM and TPH discount rate ranges for Cabot and Cimarex were relied upon. The probabilistic inputs for both Cabot and Cimarex are highlighted in Appendix 2b and 3b below.

Commodity Price Forecast

Critical to an energy-related M&A valuation analysis is the commodity price forecast used given the variability of cash flow and per share values it generates. Having a baseline commodity price forecast is required to ensure the integrity and comparability of valuation ranges, and other M&A metrics, generated. The Advisors used different price decks for both crude oil (WTI – West Texas Intermediate) and natural gas (HH – Henry Hub) per Appendix 1a below; TPH used three different pricing scenarios while JPM used one. This approach did not incorporate the expected variability of future commodity prices to allow for its impact on the valuation analysis, even though it is highly likely; a significant limitation of using a deterministic approach.

A probabilistic approach to commodity price forecasts incorporates this variability in a manner that reflects historical price dynamics, though this can be changed where past behavior is not regarded as a good proxy for the future. This paper uses a time-series function to calculate and incorporate the dynamic nature of future WTI and HH prices. Using annual WTI and HH data since 2000, the WTI and HH commodity price forecasts were generated per Appendix 1b below. This approach incorporates the actual variability of commodity prices and eliminates the need for randomly choosing the most likely price forecast, or range of forecasts, as incorporated in the JPM and TPH analyses. And it also ensures the valuation and M&A

metrics are directly comparable, unlike in the JPM and TPH analyses, thereby enhancing their insights to the Transaction evaluation process.

A review of the JPM and TPH commodity price forecasts versus a probabilistic price forecast, per Appendix 1b, highlights how the Advisors' HH price range falls below the long-term projected mean while the WTI price reflects the long-term projected mean; HH falls in the P25 to P35 range while WTI falls in the P40 to P60 range. This could result in Cabot being undervalued relative to Cimarex given Cabot is 100% gas-focused while Cimarex is only 43%. Using the same commodity price forecast for both Cabot and Cimarex is the only way to ensure consistency in the valuation process and a meaningful comparison of respective values.

Cabot Valuation Analysis

Using a probabilistic approach Cabot's per share value range was calculated using the NAV model, based on the assumptions per Appendix 2b below. The probabilistic valuation of Cabot, based on 50,000 iterations, provides a quantitatively rigorous, commercially likely range of values given the inherent variability in commodity prices, production and other financial variables. It also provides the probability associated with the range of potential per share values of the company. The probabilistic NAV valuation, as highlighted in Figure 2 below, is compared to the respective deterministic value ranges of JPM and TPH, and highlights their implied probability.

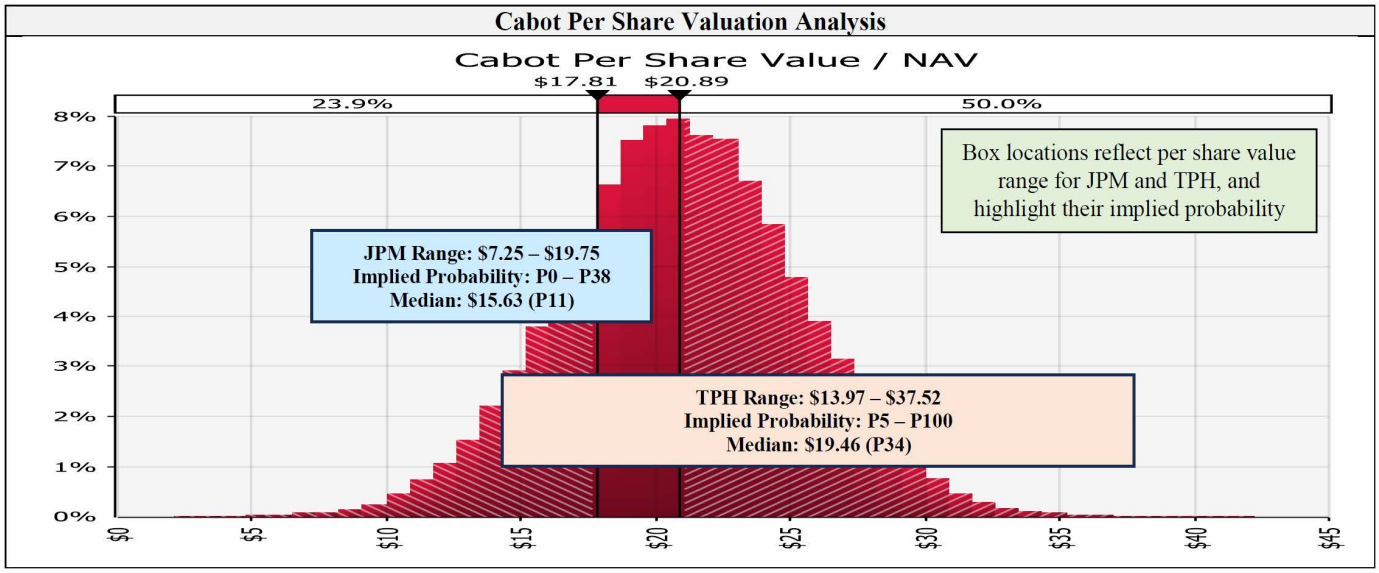

Figure 2—Cabot probabilistic per share valuation analysis.

A review of the value ranges for Cabot as calculated by each advisor (JPM in blue, TPH in orange) highlight how different they are relative to the referenced probabilistic valuation. The JPM analysis represents a range of only 38% of the probabilistic NAV range (P0 to P38), or $7.25 to $19.75. The high end of the JPM value range represents a P38 value suggesting there is a 62% probability the per share value could be higher than that value. The median value of $15.63 (P11) is 25% *lower* than the probabilistic P50 value of $20.89. The TPH analysis represents a much wider range, from P5 to effectively P100, or 95% of the value range possible. Its median value of $19.46 (P34) is 7% *lower* than the probabilistic P50 value of $20.89. These lower median values, relative to the P50 value, reflect the lower JPM and TPH gas prices used relative to the projected gas price projections per Appendix 1b.

A further review of the valuation ranges for Cabot shows little correlation to the Company's share price prior to the announcement of the Transaction. JPM's analysis reflects a median value of $15.63 per share, which is 12% *lower* than the market price of $17.81, which suggests that Cabot is overvalued. TPH's analysis

shows a median value of $19.46, which is 9% *higher* than the market price at the time of the Transaction, which suggests that Cabot is undervalued. Given the Advisor's value ranges are based on the same set of public and private data, the deterministic, subjective approach to Cabot's valuation results in disparate, and somewhat confusing, value ranges relative to the projected per share values using a more objective, probabilistic NAV approach.

A significant limitation of a deterministic approach relates to the number of data points calculated to define the value range used. By using different methodologies and selective inputs, the deterministic approach seeks to 'triangulate' around a 'reasonable' range of values implying objectivity. As noted above, this subjective approach does not fully capture the commercial range of values possible or define their specific probabilities, thus limiting its usefulness. A statistical approach, using a probabilistic analysis, will generate the data required to understand the range of potential values for the metric being evaluated and their respective probabilities. This provides the user with a far more balanced, nuanced perspective to understand the transaction metrics in an objective and quantified manner.

Cimarex Valuation Analysis

Using a probabilistic approach, Cimarex's per share value range was calculated using the NAV model, based on the assumptions per Appendix 3b below. The probabilistic valuation of Cimarex, also based on 50,000 iterations, reflects the commercially likely range of values given the inherent variability in commodity prices, production levels and other financial variables. The probabilistic NAV valuation, as highlighted in Figure 3 below, is compared to the respective value ranges of JPM and TPH, and their implied probability.

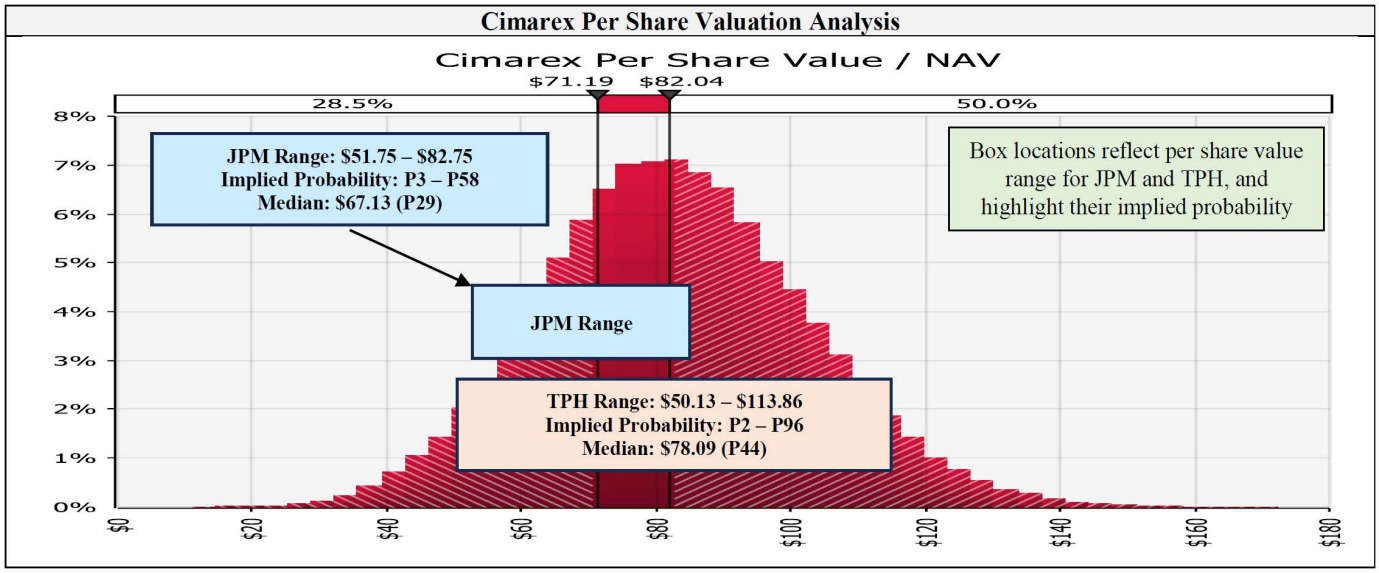

Figure 3—Cimarex probabilistic per share valuation analysis.

A review of the value ranges calculated by the Advisors highlights their differences. The JPM analysis median value of $67.13 (P29) was 18% *lower* than the probabilistic P50 value of $82.04; the value range was P3 to P58 or 55% of the probabilistic value range. The JPM range again was quite lower than that of TPH. The TPH value range represented a much wider range, from P2 to P96, or 94% of the probabilistic value range. Its median value of $78.09 (P44) was 5% *lower* than the probabilistic P50 value of $82.04.

A further review of the valuation ranges for Cimarex shows little correlation to the Company's share price prior to the announcement of the Transaction. JPM's analysis reflects a median value of $67.13 per share, which is 6% *lower* than Cimarex's market price of $71.19 while TPH shows a value range whose median value of $78.09 is 10% *higher* than Cimarex's market price at the time of the Transaction. Interestingly, the valuation discrepancy between JPM and TPH was much narrower than in the Cabot valuation, further

highlighting the inadequacies of relying on deterministic data, and different commodity price forecasts, to calculate a commercial value range across two different companies.

In reviewing the valuation analyses for Cabot and Cimarex, the question has to be asked; why is the JPM median valuation and range consistently lower than the market price and the probabilistic P50 values, while TPH's median values are consistently higher. For advisors using the same public and private data, this significant discrepancy highlights the inherent problem of relying too much on deterministic analyses. Were it not for a probabilistic approach, it would be impossible to understand the integrity of the per share value ranges for each Advisor and what this implies for the Exchange Ratio calculation as highlighted below.

M&A Transaction Metrics

While valuation models are important for understanding the intrinsic value of a company, whether used in conjunction with trading multiple analyses or not, they are critical to understanding the efficacy of an M&A transaction. For fairness opinions, the per share value ranges are used to calculate two critical transaction metrics; the Exchange Ratio and the level of accretion for the shareholders of both the acquiring and target companies. The Exchange Ratio range calculated determines whether an advisor can opine that an M&A transaction is 'fair, from a financial point of view', while the accretion analysis calculates whether the combined (or pro forma) company facilitates an increase or decrease in the value of key metrics to the transaction shareholders.

Additionally, many proxy statements, primarily through the inclusion of commentary from the Boards, highlight the extent to which the transaction is expected to lower risk to shareholders. Yet many such pronouncements are not supported with a quantitative analysis as it cannot be provided by a deterministic valuation. Fortunately, a probabilistic analysis, as highlighted below, can also provide a quantitatively based analysis of the risk to shareholders pre- and post-transaction to support this particular Transaction rationale.

Transaction Exchange Ratio Analysis

The Advisors' multiple valuation analyses were undertaken for the purpose of determining if the agreed Transaction Exchange Ratio can be supported. The graph in Figure 4 below highlights the Exchange Ratio range calculated from the probabilistic valuation analyses undertaken above, and shows the ranges for both JPM and TPH using their deterministic approach. As can be seen, the JPM Exchange Ratio range is very wide compared to that of TPH, primarily reflecting the low Cabot per share valuation analysis above.

The JPM valuation analyses resulted in a P17 to P100 Exchange Ratio range based on the probabilistic NAV valuation analysis; the median exchange ratio of 4.1775 (a P60 value) reflected a *positive* 4% difference to the 4.0146 ratio opined to be 'fair, from a financial point of view'. JPM's range was 175% wider than that of TPH. The TPH valuation analyses resulted in a P4 to P97 range; the median exchange ratio of 3.6455 (a P40 value) reflected a *negative* 9% difference to the Exchange Ratio. The P50 Exchange Ratio using the probabilistic approach was 3.9420; a 2% *difference* to the Transaction value. Given the Advisor median estimates were above and below the actual Transaction ratio, how should Boards and shareholders interpret the deterministic insights from such fairness opinions? The probabilistic approach provided a more rigorous, reliable insight into the Exchange Ratio range further highlighting its utility as an important M&A analysis tool.

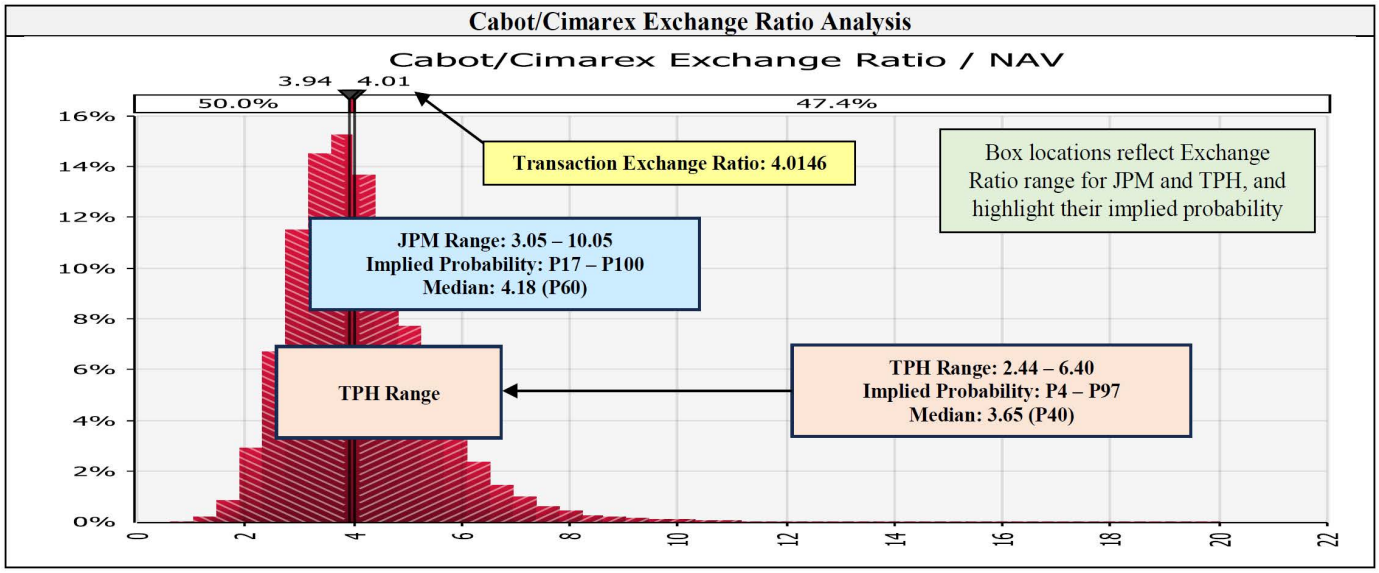

Figure 4—Cabot/Cimarex probabilistic Exchange Ratio analysis.

The differences in the JPM and TPH Exchange Ratio ranges highlight how: (i) the subjective nature of specific input estimates for the deterministic valuations led to very different Exchange Ratio values, which limited their effectiveness as a comparative tool; (ii) the lack of a baseline commodity price forecast on which to base the underlying valuations made it impossible to compare the different Advisors' Exchange Ratio ranges directly; and (iii) a deterministic approach failed to calculate the probabilities associated with the Exchange Ratio ranges and identify which Exchange Ratio was actually 'fair' from a financial point of view.

Transaction Accretion/Dilution Analysis

The valuation analyses are also used to calculate whether the Transaction is value-accretive for the acquiror and target shareholders, especially in stock-for-stock mergers. Value accretion occurs where a shareholder metric, such as per share cash flow, dividends or net asset value, is higher after the Transaction than before; it is a metric used to show how shareholders are better off from the combination of two companies versus remaining independent. NAV per share is the shareholder metric evaluated in this analysis.

Transaction cost savings/synergies and expenses were also included in this analysis resulting in a value range of $750 million to $1,250 million (after tax) being added to the combined company equity value based on the discount rates used. Transaction cost savings and synergies are often a significant rationale for mergers and acquisitions. They reflect the financial benefits that accrue to the pro forma company shareholders, through operational economies of scale and scope, eliminating redundant positions and their associated expenses, and lower capital costs, in the combined company. Understanding and valuing these benefits, reduced by the impact of any transaction costs such as bankers' fees, is critical to ensuring the full economic impact is included in the analysis. The Proxy Statement included a description of how the synergies/cost savings were expected to be achieved and their expected per annum value.

The resulting accretion analyses for Cabot and Cimarex shareholders, reflecting their pro forma ownership interest in the combined company, using a probabilistic approach, are shown in Figure 5 below along with the respective Advisors' ranges; these ranges were only calculated for their specific client. JPM disclosed one value while TPH disclosed two distinct value ranges based on two of their three production scenarios using the three different commodity price forecasts.

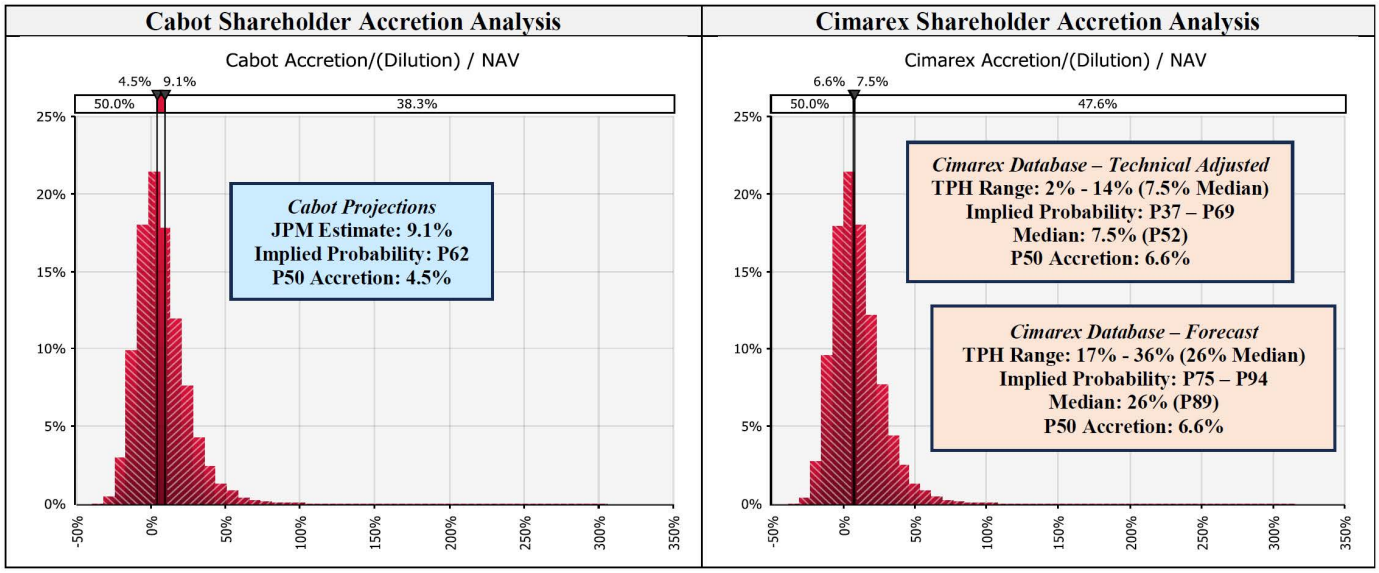

Figure 5—Cabot and Cimarex probabilistic accretion/dilution analyses.

The P50 accretion for Cabot was 4.5% versus the 9.1% calculated by JPM. Based on the probabilistic NAV analysis, there was a 62% probability accretion would be lower than the JPM estimate; there was also a 36.7% probability the Transaction would be dilutive (accretion less than 0%). Cost savings and synergies were critical for Cabot shareholders to achieve any accretion; a $255 million (P50) after-tax value present value was required for Cabot shareholders to achieve an accretive transaction. The P50 accretion for Cimarex was 6.6% versus the median values of 7.5% and 26% calculated by TPH. Based on the probabilistic NAV analysis, there was a 52% probability accretion would be lower than 7.5% and an 89% probability it would be lower than 26%; there was a 31.4% probability the Transaction would be dilutive. Where no synergies were achieved, the Transaction was 0.5% (P50) accretive for Cimarex shareholders.

Transaction Risk Analysis

A fundamental part of any M&A analysis is to understand the pro forma per share value risk profile and the extent to which shareholder risk changes given their ownership in an enlarged company. In the Proxy Statement, both the Cabot and Cimarex Boards represented the Transaction was expected to reduce the level of risk (directly and indirectly) from both an asset and capital structure perspective. This was premised on: (i) an increase in the scale of the business; (ii) the diversification of the asset portfolio across commodities and regions; (iii) the synergies forecast to be generated; and (iv) a lower cost of debt and equity capital reflecting the enhanced balance sheet.

However, a deterministic approach cannot quantify whether the risk to shareholders in the pro forma company has changed relative to the risk experienced as a shareholder in an acquiror or target company. In this Transaction, neither the Advisors nor the Boards provided any quantitative insight into how shareholder risk had changed, which is critical to supporting the representations made by the Boards. A probabilistic approach provides this information through using existing engineering risk metrics; risk analysis tools that can only be applied where a probabilistic output is generated. In this analysis, two simple metrics were used to calculate how the risk for shareholders in Cabot and Cimarex changed due to owning shares in the pro forma company; the P90/P10 ratio of the per share value range and the related coefficient of variance ('COV') ratio (standard deviation/P50 of per share value range), pre- and post-transaction. These are traditional risk metrics also used regularly from both a geoscience and engineering perspective.

Interestingly, this risk analysis also provides an insight into the discount rate to be used in valuing the pro forma company. Where the analysis shows that shareholder risk decreases, so should the equity discount rate; where the risk increases, so should the equity discount rate. Understanding the directional

changes in shareholder risk are critical as this will impact how the discount rate and equity value of the combined company can be expected to change over time. This approach does not calculate what the pro forma discount rate should be; it instead highlights another benefit of a transaction that cannot be quantified from a deterministic perspective. Per Figure 6 below, the pre-transaction calculations of per share risk for Cabot and Cimarex shareholders are compared to the pro forma per share value range and related risk metrics. To facilitate this analysis, the Cimarex per share value was adjusted by the Exchange Ratio to an equivalent Cabot pre-transaction price to provide a better pre-and post-transaction analysis baseline.

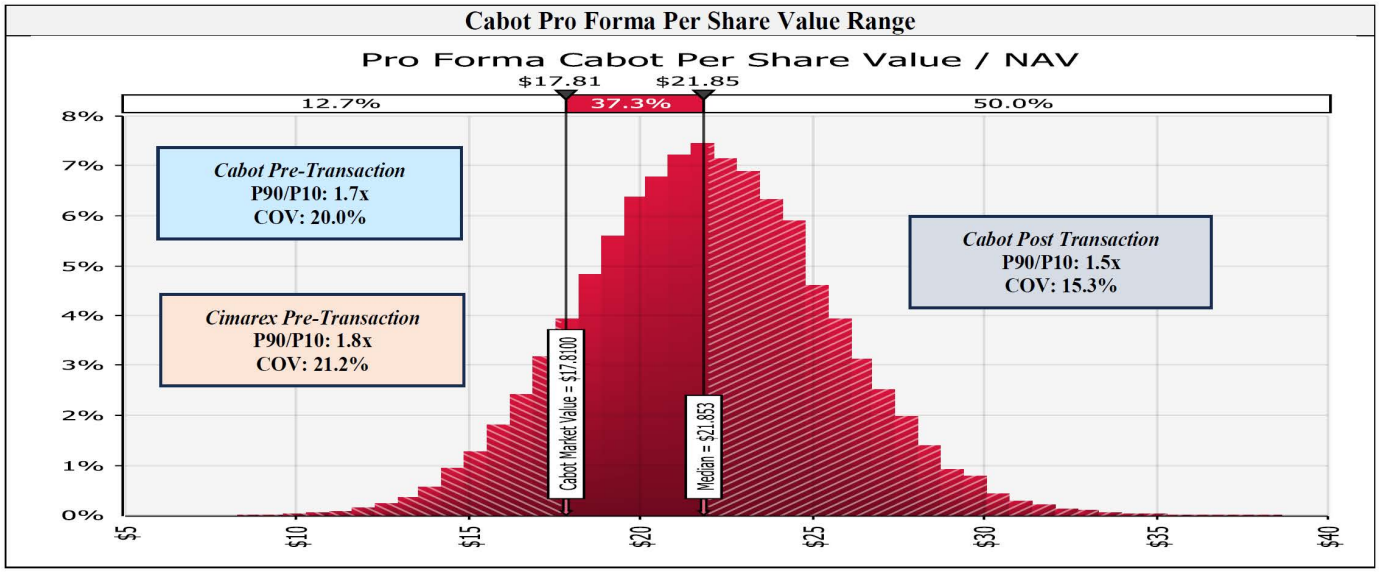

Figure 6—Cabot/Cimarex pro forma probabilistic value range and risk analysis.

The P90/P10 value for Cabot was 1.7x on a standalone basis while the COV was 20.0% per the graph above. The P90/P10 value for Cimarex was 1.8x on a standalone basis while the COV was 21.2% per the graph above. On a pro forma basis, the P90/P10 value declined to 1.5x while the COV declined to 15.3%; a material reduction in the per share risk metrics for both Cabot and Cimarex shareholders. This analysis confirms the risk reducing benefits of the Transaction as articulated, but not quantified, in the Proxy Statement by both Boards. It also highlights the average 22% reduction in risk, as calculated based on the change in the P90/P10 and COV ratios, which suggests the pro forma discount rate should be lower, thus further supporting the value accretive nature of the Transaction. This impact has not been included in the pro forma NAV model discount rates used.

A probabilistic approach also provides significant insights into how the input variables impact the output value range; insights not available from a deterministic analysis. This is particularly helpful to Boards as it highlights those inputs that will have the greatest impact on underlying value, helping them to understand the key value-driving levers for the company. The sensitivity analysis in Figure 7 below highlights the ranking of input metrics that drive the per share value variability seen in Figure 6 above, with gas, oil and NGL prices the most significant drivers. It also highlights how the Cimarex production profile and operating and capital costs are important drivers for future company value accretion relative to the Cabot asset portfolio; an important insight for corporate strategy and business plan development.

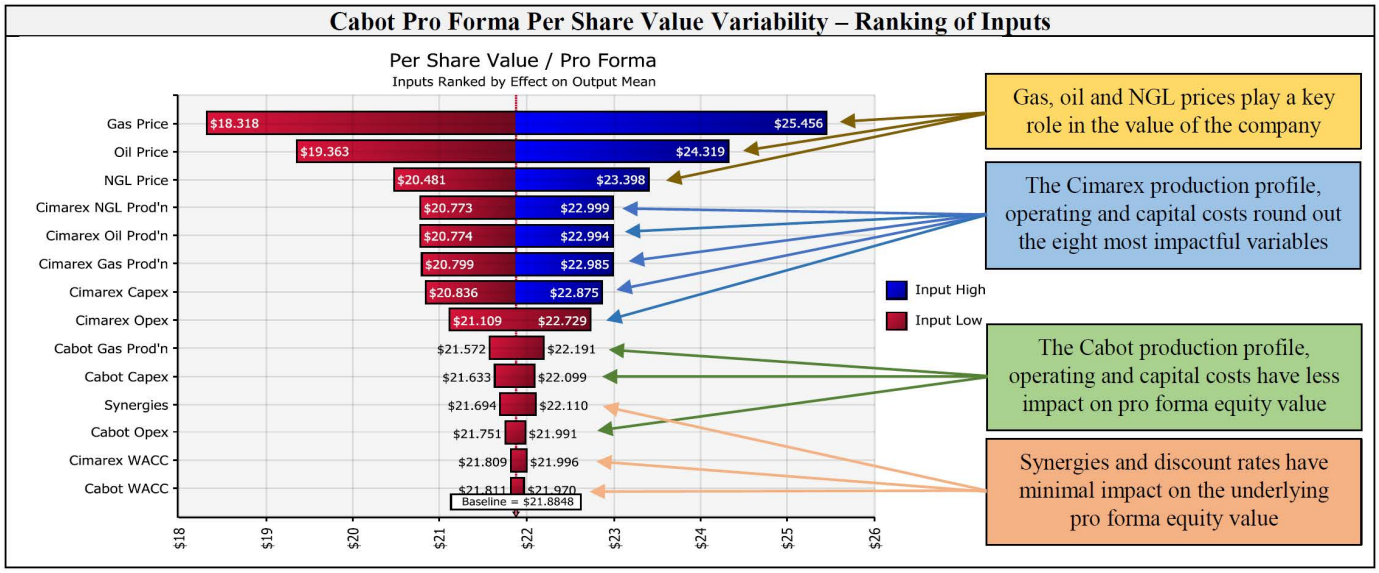

Figure 7—Cabot/Cimarex pro forma input variable contribution to per share value variability. Blue shows >15% correlation to per share value changes.

Another important insight from a probabilistic analysis for both Cabot and Cimarex shareholders is the share price upside possible post the Transaction. Including the effect of projected synergies, there was an 87% probability the Cabot stock price would increase from the pre-Transaction announcement price of $17.81 per Figure 6 above. This analysis does not highlight when these higher values could be achieved, but it does highlight the probability of achieving them. As I submit this paper (July 28, 2024), Coterra Energy Inc. (NYSE: CTRA), the renamed Cabot/Cimarex combination, is valued at $25.78 per share; a 45% increase in value post the Transaction.

Agency Risk Considerations

Agency risk is based on conflicts of interest that arise where one party (the agent) is expected to act in the interests of another party (the principal) when the agent's own interests may conflict with those of the principal. In this paper, Cabot and Cimarex (the principals) are exposed to the risk that JPM and/or TPH (the agents) structure their respective analyses to assure completion of the Transaction to receive their significant transaction-based fees. The realization of agency risk could not be ruled out if the Exchange Ratio of 4.0146 was not fully supportable and the levels of accretion calculated by the Advisors were not possible. Given the JPM and TPH deterministic analyses undertaken to support the Exchange Ratio, and their inherent subjectiveness and limitations as noted above, can a probabilistic approach also confirm the objectivity of the Advisors' opinions. thereby reducing this particular risk?

In this case, using a probabilistic approach, the 4.0146 Exchange Ratio was clearly supported as it represented a P53 value compared to the P50 probabilistic value of 3.9420; an insight the JPM and TPH analyses could not provide. The Transaction was also accretive for Cabot and Cimarex shareholders, based on the P50 outcomes, though not at the levels projected by the Advisors. A probabilistic approach would have addressed the Cabot and Cimarex Boards' concerns with agency risk as it confirmed the Advisors' opinions even though there was uncertainty as to why the chosen methodologies and inputs were used, and a significant degree of variability in their respective M&A metric ranges.

Probabilistic Advantages For M&A Process

Utilizing a probabilistic approach materially upgraded the Transaction evaluation and analysis process through enhancing the quality of the key decision-making metrics. An overview of the advantages of using a probabilistic approach versus a deterministic approach, per Table 3 below, highlights their structural

and analytical ability to better incorporate the underlying stochastic reality of the E&P industry into our models. Importantly, most disadvantages can be easily mitigated through collecting the correct data to reflect the commercial variability of the underlying model inputs and gaining more experience in applying a probabilistic approach on a regular basis.

Table 3—Overview of pros and cons of a probabilistic approach versus a deterministic approach.

Probabilistic Approach Pros/Cons Versus Deterministic Approach	
Pros	• Facilitates use of significantly more information with respect to inputs and correlation coefficients/copulas. • Highlights probabilities of different outcomes and provides a range of objective risk analysis metrics. • Does not require 'rules of thumb' and/or 'guesstimates' regarding input data for sensitivity analyses. • Ranks input variable contributions to output variability and quantifies contribution through multiple graphs. • Reduces model cycle time/cost and provides an order-of-magnitude greater insight into real-world variability. • Mitigates agency risk given inherent problems of using deterministic analyses to support a transaction opinion.
Cons	• Subjective choices required where 'real-world' data does not exist for important input metrics and correlations. • Users may not know how to use the software initially leading to nonsensical and non-commercial outputs. • Output data in presentations may not be initially understood where users are not versed in meaning and application. • Lack of direct comparability across the industry given limited current use as a primary finance function tool.

A review of the Transaction reinforces the significant advantages gained from using a probabilistic approach versus the traditional deterministic approach. Simply, the deterministic approach, used by both Advisors, did not provide sufficient quantitative clarity as to whether the Transaction was 'fair, from a financial point of view'. There was no sense for the likelihood of occurrence of the Exchange Ratio or accretion values provided in the fairness opinions. The use of different trading multiple ranges, DCF and NAV valuation methodologies, commodity price forecasts, production, EBITDAX and capital expense inputs meant it was difficult to inherently understand, and trust, the conclusions drawn. With no baseline commodity price forecast, and no relationship highlighted between the different financial projection cases used, it was not possible to reconcile the data in a way that allowed for a reasonable comparison of per share values, the Exchange Ratio and projected accretion. In many ways the Exchange Ratio could not be considered 'fair' as the Advisors: (i) used different methodologies and inputs; (ii) calculated different value ranges on which it was based; and (iii) could not provide probabilities around the likelihood of the value ranges being achieved.

Unlike the JPM and TPH analyses, a probabilistic approach incorporated the variability of the inputs driving the critical transaction metrics (per share value, exchange ratio, accretion value) in an objective, dynamic fashion. It calculated the P50 Exchange Ratio of 3.9420, against which to evaluate the Transaction ratio of 4.0146, to confirm it was 'fair, from a financial point of view'. It equally provided the P50 levels of per share accretion for both Cabot and Cimarex shareholders in a way the JPM and TPH analyses did not. More importantly, it confirmed the Transaction facilitated a reduction in risk as reflected in the standalone versus pro forma P90/P10 and COV values. It also highlighted and ranked, per the pro forma sensitivity analysis graph, the critical factors driving value creation in the pro forma company. The probabilistic approach also reduced the agency risk issue as the Transaction metrics were based on objective, probability-derived values rather than subjectively chosen values with no sense for their actual likelihood.

Conclusion

The probabilistic approach to analyzing the Cabot/Cimarex Transaction resulted in a significantly enhanced, quantitatively rigorous valuation and financial analysis that more accurately included real-world data and uncertainty in operational and financial inputs. This approach generated the full range of possible outcomes for the key M&A transaction metrics including: (i) company valuations; (ii) the Exchange Ratio; and (iii) per share value accretion, thereby providing a meaningful baseline off which to fully evaluate the

Transaction. The metric outputs also provided greater commercial insight into pre- and post-transaction shareholder risk through the application of P90/P10 and COV ratios; values not available in a deterministic analysis. Ultimately, the probabilistic approach facilitated a more transparent, insightful analysis on which to conclude the Exchange Ratio of 4.0146 was 'fair, from a financial point of view' than that provided by a deterministic approach, thereby confirming its intrinsic value to the M&A process.

In addition to the advantages highlighted above, there are other important reasons to consider using a probabilistic approach for the M&A process and/or the broader finance function. Boards are required to exercise a duty of care which includes using the tools and processes most appropriate to the organization based on its risks and their prudent management. Given the significant limitations associated with using a deterministic approach, and the need to incorporate the dynamic nature of the business environment into our financial analyses, it is important to use tools that include more relevant data and generate enhanced insights. A probabilistic approach to financial modeling will achieve these twin goals. A probabilistic approach is equally a critical auditing tool, especially where an organization continues to use a deterministic approach, to confirm the appropriate input ranges and the probability associated with the single value outputs generated. In conclusion, undertaking M&A using a probabilistic approach will: (i) facilitate enhanced insights into the critical transaction metrics; (ii) significantly upgrade the decision-making process; (iii); reduce the inherent agency risk; and (iv) support the Board in meeting its broad fiduciary obligations; key upgrades that will only increase the probability of M&A success from the low levels experienced in the energy industry today.

Acknowledgements

Thank you to Steve Begg[8], Emeritus Professor, Australian School of Petroleum at the University of Adelaide, whose insights, comments and support for this paper were invaluable and gratefully received; to Ben Nathan for his support, encouragement and connections when this paper was barely the spark of an idea; and to the industry professors and professionals, whom I have worked with over many years, whose teachings and conversations laid the groundwork underlying this paper's approach, analysis and insights.

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7. Cimarex Energy Co. Form 10-Q for the quarterly period ended March 31, 2021. https://www.sec.gov/Archives/edgar/data/1168054/000116805421000018/xec-20210331.htm
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Appendix 1

Commodity Price Assumptions

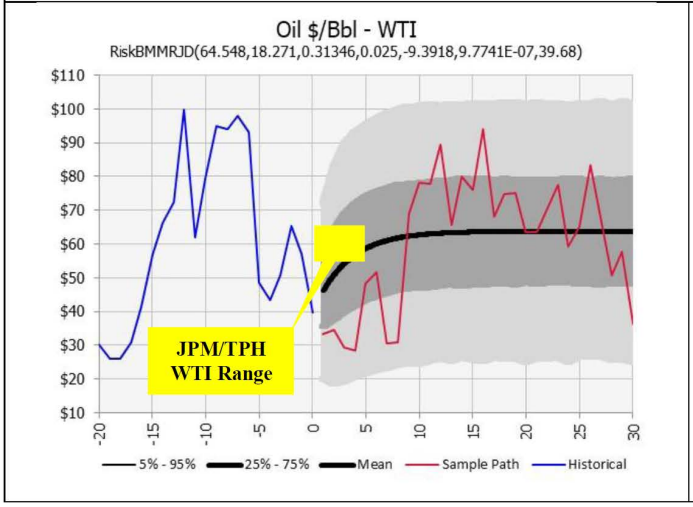
Deterministic Pricing Assumptions[2]

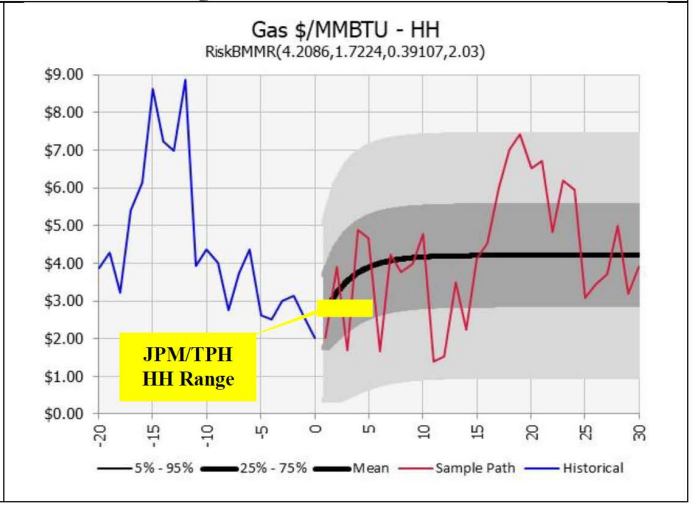
Crude Oil Pricing Assumptions					
JPM and TPH Oil Price Projections – WTI ($/Bbl)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$56.24	$55.00	$55.00	$55.00	$55.00
TPH – NYMEX	$62.74	$59.29	$56.08	$54.00	$52.73
TPH – Wall Street	$64.75	$62.82	$61.00	$61.00	$61.00
TPH – 3 Yr. Avg.	$53.11	$53.11	$53.11	$53.11	$53.11

Natural Gas Pricing Assumptions					
JPM and TPH Gas Price Projections – HH ($/MMbtu)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$2.74	$2.75	$2.75	$2.75	$2.75
TPH – NYMEX	$2.98	$2.80	$2.61	$2.60	$2.62
TPH – Wall Street	$2.74	$2.93	$3.00	$3.00	$3.00
TPH – 3 Yr. Avg.	$2.62	$2.62	$2.62	$2.62	$2.62

Probabilistic Pricing Assumptions

Based on 2000-2020 Historical Pricing

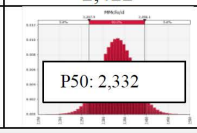
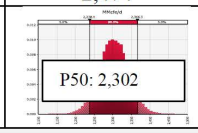
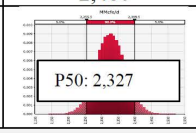
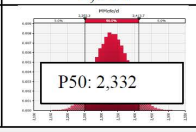
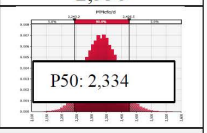
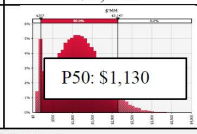
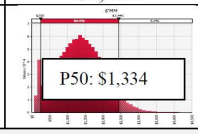
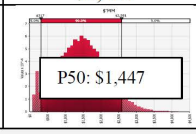
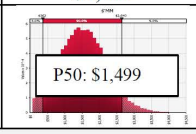
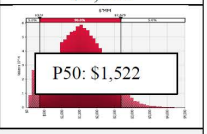
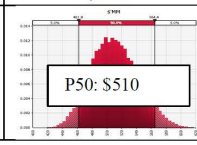
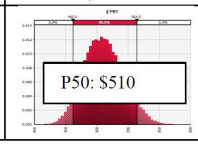
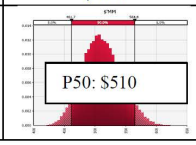
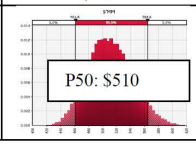
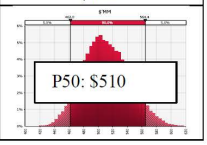




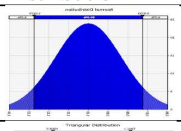
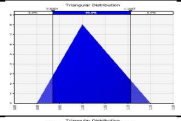
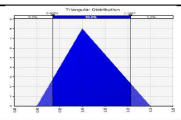
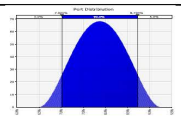
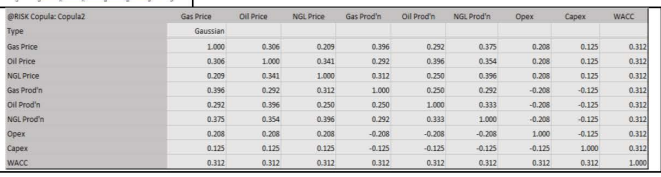
Appendix 2

Cabot Valuation Assumptions

Cabot Selected Financial Model Inputs

Production (MMcfe/d) – TPH converted from Mboe/d					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	2,332	2,328	2,382	2,402	2,434
TPH-Average	2,422	2,474	2,480	2,514	2,536
Probabilistic Range per Inputs Below					
EBITDAX ($'MM)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$1,141	$1,360	$1,286	$1,327	$1,311
TPH-Average	$1,379	$1,466	$1,437	$1,467	$1,470
Probabilistic Range per Inputs Below					
Capital Expenses ($'MM)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$543	$501	$513	$524	$505
TPH-Average	$523	$517	$484	$457	$493
Probabilistic Range per Inputs Below					

Cabot Probabilistic Model Input Distributions and Rationale

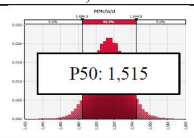
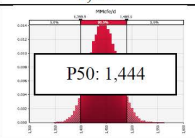
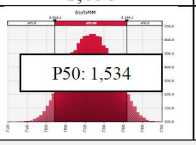
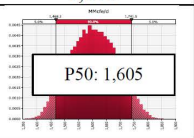
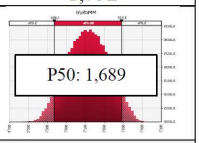
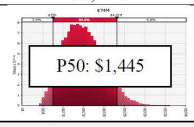
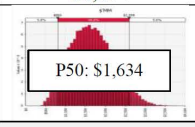
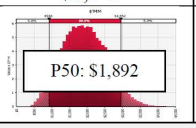
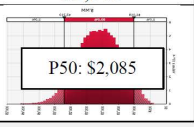
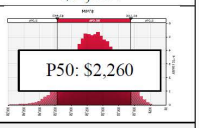
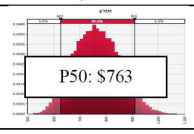
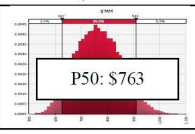
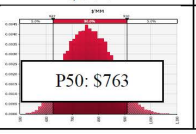
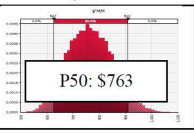
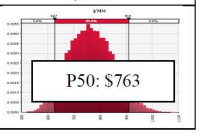
Input	Distribution	Rationale
Production		Normal Distribution based on production from proved reserves +/- 5% as definition of proved reserves is 90% probability of being recovered. Given quality of reserves and Marcellus production leadership, this range of production values was considered appropriate for Cabot.
Operating Costs		Triangular Distribution based on 90% - 115% of projected operating costs. This takes into consideration the potential for greater operating efficiencies and the risk of inflation pushing operating costs higher and/or operational problems experienced.
Capital Costs		Triangular Distribution based on 90% - 115% of projected capital costs. This takes into consideration the potential for greater drilling and completion efficiencies, as had been exhibited in prior years, and the risk of inflation pushing capital costs higher and/or operational problems experienced.
Discount Rate		Pert distribution based on discount rate provided by JPM and TPH (7.25% - 8.75%). Each Advisor had different assumptions (JPM: 8.25% - 9.25%) and TPH (6.50% - 8.00%) so a middle range was chosen for this valuation analysis.
Correlation Factors		Correlation (Copula) coefficients between input variables based on historical data, where available, and commercial expectations.

@RISK Copula: Copula2	Gas Price	Oil Price	NGL Price	Gas Prod'n	Oil Prod'n	NGL Prod'n	Opex	Capex	WACC
Type	Gaussian								
Gas Price	1.000	0.306	0.209	0.396	0.292	0.375	0.208	0.125	0.312
Oil Price	0.306	1.000	0.341	0.292	0.396	0.354	0.208	0.125	0.312
NGL Price	0.209	0.341	1.000	0.312	0.250	0.396	0.208	0.125	0.312
Gas Prod'n	0.396	0.292	0.312	1.000	0.250	0.292	-0.208	-0.125	0.312
Oil Prod'n	0.292	0.396	0.250	0.250	1.000	0.333	-0.208	-0.125	0.312
NGL Prod'n	0.375	0.354	0.396	0.292	0.333	1.000	-0.208	-0.125	0.312
Opex	0.208	0.208	0.208	-0.208	-0.208	-0.208	1.000	-0.125	0.312
Capex	0.125	0.125	0.125	-0.125	-0.125	-0.125	-0.125	1.000	0.312
WACC	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	1.000

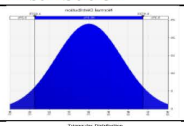
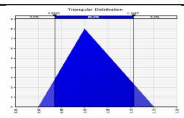
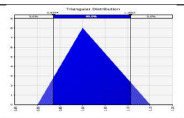
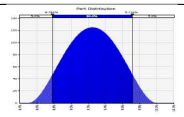
Appendix 3

Cimarex Valuation Assumptions

Cimarex Selected Financial Model Inputs

Production (MMcfe/d) – TPH converted from Mboe/d					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	1,416	1,464	1,566	1,602	1,572
TPH-Average	1,450	1,554	1,658	1,696	1,732
Probabilistic Range per Inputs Below					
EBITDAX ($'MM)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$1,446	$1,560	$1,780	$1,832	$1,783
TPH-Average	$1,546	$1,794	$1,949	$1,985	$2,037
Probabilistic Range per Inputs Below					
Capital Expenses ($'MM)					
	2021	**2022**	**2023**	**2024**	**2025**
JPM	$707	$779	$812	$793	$849
TPH-Average	$588	$660	$670	$679	$665
Probabilistic Range per Inputs Below					

Cimarex Probabilistic Model Input Distributions and Rationale

Input	Distribution	Rationale
Production		Normal Distribution based on production from proved reserves +/- 5% as definition of proved reserves is 90% probability of being recovered. Given quality of reserves and Permian production leadership, this range of production values was considered appropriate for Cimarex
Operating Costs		Triangular Distribution based on 90% - 115% of projected operating costs. This takes into consideration the potential for greater operating efficiencies and the risk of inflation pushing operating costs higher and/or operational problems experienced.
Capital Costs		Triangular Distribution based on 90% - 115% of projected capital costs. This takes into consideration the potential for greater drilling and completion efficiencies, as had been exhibited in prior years, and the risk of inflation pushing capital costs higher and/or operational problems experienced.
Discount Rate		Pert distribution based on discount rate provided by JPM and TPH (8.50% - 10.00%). Each Advisor had different assumptions (JPM: 9.50% - 10.50%) and TPH (8.00% - 9.75%) so a middle range was chosen for this valuation analysis.
Correlation Factors		Correlation (Copula) coefficients between input variables based on historical data, where available, and commercial expectations.

@RISK Copula: Copula2	Gas Price	Oil Price	NGL Price	Gas Prod'n	Oil Prod'n	NGL Prod'n	Opex	Capex	WACC
Type	Gaussian								
Gas Price	1.000	0.306	0.209	0.396	0.292	0.375	0.208	0.125	0.312
Oil Price	0.306	1.000	0.341	0.292	0.396	0.354	0.208	0.125	0.312
NGL Price	0.209	0.341	1.000	0.312	0.250	0.396	0.208	0.125	0.312
Gas Prod'n	0.396	0.292	0.312	1.000	0.250	0.292	-0.208	-0.125	0.312
Oil Prod'n	0.292	0.396	0.250	0.250	1.000	0.333	-0.208	-0.125	0.312
NGL Prod'n	0.375	0.354	0.396	0.292	0.333	1.000	-0.208	-0.125	0.312
Opex	0.208	0.208	0.208	-0.208	-0.208	-0.208	1.000	-0.125	0.312
Capex	0.125	0.125	0.125	-0.125	-0.125	-0.125	-0.125	1.000	0.312
WACC	0.312	0.312	0.312	0.312	0.312	0.312	0.312	0.312	1.000