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Statistical Methods in Valuation Analysis: Coefficient of Variation (Part Three of a Six-Part Series)

This third installment of the six-part *Health Capital Topics* series on the application of statistical methods by valuation analysts will provide a brief overview of the *coefficient of variation* (CVAR) and its utilization on various valuation techniques and methodologies. The (CVAR) is a convenient measure of *dispersion*, i.e., the amount of spread in the data,[1] which describes the variance of data relative to its mean.[2] It is calculated as the standard deviation of the subject sample divided by the mean of such sample, as demonstrated in the equation below:[3]

$$CVAR = \frac{Sample\ standard\ deviation}{Sample\ mean}$$

The size of the CVAR can be interpreted as a measure of the relative spread of the sample data. As the calculated CVAR approaches zero, this indicates less relative dispersion within the sample; inversely, a CVAR moving away from zero signifies a greater level of dispersion. When the sample standard deviation is greater than the sample mean, this will produce a CVAR with a coefficient greater than one. If this occurs, it indicates that both positive and negative values exist within one standard deviation of the sample mean; the interpretation of this result varies depending on the data and how they are measured. For instance, when conducting a valuation analysis, suppose the estimated value of a company – the sample mean – is a positive number, but the standard deviation is greater than that estimated value. Thus, one standard deviation below the estimated value has to be a negative number; depending on the data being analyzed, the switch in sign may be significant, e.g., if analyzing measures of profit, the potential for a negative profit may indicate significant risks as compared with a data set indicating a CVAR below one (1).

However, because the sample mean is the denominator of the equation, one limitation of the CVAR is that the mean can never equal zero.[4] Therefore, if zero is the expected value when conducting a valuation, the CVAR is a not useful statistic to calculate. Simply one advantage of using the CVAR in contrast to other measures of dispersion, such as standard deviation and variance, is that it is independent of units of measurement, i.e., the calculated CVAR is a percentage that can be compared across data sets, regardless of whether they use different units of measurement.[5] For example, if one set of data is measured in pounds and another in kilograms, the CVAR would allow a researcher to compare the dispersion between the two sets without having to perform unit conversions. Additionally, the CVAR is also useful in the comparison of dispersion between multiple sets of data that have the same unit of measurement, yet different means and standard deviations.[6]

CVAR is a popular statistic in research across the medical, physical, and social sciences,[7] and has been in use since the early twentieth century.[8] One way the CVAR has been used in valuation analysis, in particular, is to compare how accurately different models can arrive at an estimate.[9] For example, in the case of valuing the welfare of environmental quality, one researcher used the CVAR as a way to compare the results of two regression models (see the fifth installment of this six-part series for more information on regression analyses) to determine which fit the data best.[10] Further, the CVAR may also be useful in the measurement of risk, i.e., the degree of uncertainty for an entity.[11] For example, an entity's risk stems from fluctuations in both consumer sales and its level of fixed costs.[12] Thus, it is important from a valuation perspective to estimate risk in order to understand the reliability of the future income flow of the entity, which forms the basis of value. The CVAR provides insight into the relative certainty of performance indicators that will influence an analyst's perspective on the riskiness of the investment in the subject property.

A CVAR calculation may also support the development of defensible *financial forecasts* in a valuation analysis. Opining on the value of a healthcare enterprise, asset, or service is a function of many variables, many of which are unknown and/or may be influenced by events that have not yet occurred.[13] In light of this reality, valuation analysts may find it prudent to conduct *sensitivity analyses* to determine the level of uncertainty associated with their estimates. For instance, if two companies have a forecasted growth of two percent for the following year, yet one company has grown exactly two percent for the past ten years and the other has grown between 0.5 and four (4) percent for the past ten (10) years, the forecast for the latter company may be subject to increased variation, which may decrease the confidence of the forecast for the latter company relative to the former company. A valuation analyst may measure his or her

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confidence in the forecast by calculating the CVAR, with a lower figure indicating greater certainty that the forecast will be accurate. For the purpose of a valuation analysis, the confidence of a forecast is important because increased certainty means a lower perceived risk,[14] which may translate into a lower risk premium and, thereby, a lower discount rate.[15]

Determining an appropriate discount rate is among the essential components of a defensible valuation opinion, as it allows the value of an enterprise, asset, or service to be calculated more accurately as the researcher estimates into the future.[16]

In addition to utilizing the CVAR in financial forecasting, this measure also supports the valuation analyst's synthesis of *benchmark comparisons*. *Benchmark comparisons* allow a valuation analyst to determine how an individual company varies from industry norms.[17] For example, if a hospital in Missouri sought to determine whether the compensation paid to its hospital-based physicians is in accordance with industry norms in the state, the analyst may either: (1) locate compensation data for this population across Missouri and compute a mean and standard deviation for the data; or, (2) utilize previously collected survey data on this metric.[18] CVAR is important in this scenario, as this technique provides the analyst with an indication of the relative volatility within the industry. A higher CVAR denotes a wider relative variation among the studied population for the metric at issue, whereas a lower CVAR signifies relative stability for this metric. If the hospital determined that compensation fell outside of the industry normative benchmark or survey data, the CVAR may be a useful tool in determining where the researcher should focus their concern. If the CVAR for industry compensation is high (indicating high volatility in the industry relative), falling outside of the normative benchmark may be a sign of industry/survey volatility, rather than the individual hospital being a potential outlier.[19] However, if the CVAR for industry compensation is low (indicating low volatility in the industry), the hospital may be paying its physicians more or less than the market for hospital-based physicians in a geographic area.

Although the CVAR has wide applications in valuation analyses, utilization of this technique is subject to certain limitations. As mentioned earlier, for a sample mean that approaches zero, the CVAR approaches infinity and eventually becomes undefined,[20] rendering this metric ineffective. Further, the CVAR works better with large sample sizes[21] and is subject to the same biases as its underlying measures: the standard deviation and mean. The presence of certain abnormalities in a sample, such as outliers, could introduce bias into the CVAR by affecting the accuracy of the underlying data. This potential problem highlights the importance of utilizing sufficiently sized data sets and avoiding *sample bias*.[22]

Analysts should consider the utility of the CVAR described above when conducting valuations of an enterprise, asset, or service. In particular, the CVAR may support the defensibility of a particular *financial forecast* or *benchmark comparison* depending on the needs set forth in the engagement and the data being studied, so long as the statistic is not misused or misrepresented in the analysis. The fourth installment of this six-part series will discuss *data sets and samples*, their impact on valuation analyses, and potential pitfalls or mistakes in their interpretation.

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1 "Basic Business Statistics: Concepts and Applications" By Mark L. Berensen, et al., Upper Saddle River, NJ: Pearson Education, Inc., 1992, p. 94.
2 *Ibid,* p. 99.
3 *Ibid.*
4 "Introductory Applied Statistics in Science" By Sung C. Choi, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1978, p. 68.
5 *Ibid.*
6 Berenson, et al., 1992, p. 99-100.
7 "The mean-variance ratio test-A complement to the coefficient of variation test and the Sharpe ratio test" By Zhidong Bai et al., Statistics and Probability Letters, Vol. 81 (2011), p. 1078.
8 "Selecting Capital Projects with the Coefficient of Variation: 1. Introduction" By James S. Osteryoung et al., Financial Management, Vol.6, No. 2, (Summer 1977), p. 65.
9 "Finding Sensitivity to Scope in Nonmarket Valuation" By Juha Siikamaki and Douglas M. Larson, Journal of Applied Econometrics, Vol. 30, (October 2013), p. 333-334.
10 *Ibid,* p. 347.
11 "Valuing a Business: The Analysis and Appraisal of Closely Held Commodities" By Shannon P. Pratt and Alina V. Niculita, New York, NY: McGraw-Hill, 2008, p. 160.
12 *Ibid*, p. 160-161.
13 "Healthcare Valuation – The Financial Appraisal of Enterprises, Assets, & Services" By Robert James Cimasi, MHA, ASA, FRICS, MCBA, CVA, CM&AA, Volume 2, Hoboken, NJ: John Wiley & Sons, 2014, p. 52.
14 *Ibid, p. 36.*
15 *Ibid.*
16 *Ibid,* p. 89.
17 *Ibid,* p. 119.
18 *Ibid,* p. 122.
19 *Ibid,* p. 119-120.
20 Choi, 1978, p. 68.
21 Bai et al, 2011, p. 1078.
22 For more information on sample bias, see Part Two of this series entitled, "*Statistical Methods in Valuation Analysis: Descriptive Statistics.*"

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