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Using
Cohen's d
to measure effect size

Effect Size: a measure of the strength of a relationship between variables.

In domains heavily concentrated in statistics and econometrics such as financial economics, we often need to know the impact a variable has on another variable; or we may need to know the impact a group of variables has on a variable. As an example, we often need to calculate the impact GDP has on the market, or S&P 500, assuming the impact indeed holds true. In scientific terms, we refer to this impact as *effect*, e.g., the *effect* GDP has on the market. In lay terms, consider effect loosely analogous to the term *strength*. As another example, we may need to know the effect US spending in the energy sector has on Exxon Mobil Corporation's stock price, XOM. We then may want to know the strength of the effect spending has on XOM, so we can gain a better understanding into how spending effects variance within XOM. In a business environment, we may want to know the effect sales has on net profit, or the effect marketing has on sales.

At Xicon, we most often use an F-test to determine effect coupled with a p-value to determine its alpha level, followed by Cohen's d or Hedge's G to determine effect size, depending upon the respective differences between the standard deviations of the variables in consideration. Though we will save Hedge's G for another day, Cohen's d is a measure of effect size using the standardized difference between two means, and

while these calculations may sound complicated, the calculations are easier to understand than their interpretation.

Cohen's d is calculated using the following simple equations and rubric.

Eq. 1: $$Cohen's\ d = \frac{M_2 - M_1}{SD_{pooled}}$$

Eq. 2: $$SD_{pooled} = \sqrt{\frac{SD_1^2 + SD_2^2}{2}}$$

Where, M_1 = mean 1
M_2 = mean 2
SD_1 = standard deviation 1
SD_2 = standard deviation 2

Rubric:

small effect	0.200
medium effect	0.500
large effect	0.800

Assume the F-test we previously conducted was statistically significant at the .01 alpha level. Hence, we now know the effect was likely not due to chance. But we also want to gain an understanding as to the strength of this effect. Using Cohen's d and comparing it against the rubric, we can determine the strength of the effect, or the effect size.

Cohen's d provides advantages over relying on significance testing alone, as Cohen's d is deemed as a measure of practical significance. However, Cohen's d also has disadvantages, one main disadvantage of which is that there is a lack of directionality, meaning Cohen's d only quantifies the strength, or magnitude, of the difference between the means. Cohen's d is unitless, but it is analogous to speed verses velocity in that speed is a scalar quantity while velocity is a vector quantity; speed can be expressed as a magnitude, like Cohen's d, as speed has no direction. Conversely, velocity has both magnitude and direction. This is why engineers provide drivers a speed limit as opposed to a velocity limit. To give us a velocity limit, engineers would be forced to state the allowable speed, e.g., miles per hour, along with as stated direction, e.g., bearing.

Additionally, Cohen's d assumes normality, meaning the data are assumed to be normally distributed—but such is often not the case, especially in equity data where output can be negatively or positively skewed. Hence, the skewness can result in flawed effect sizes.

Further, Cohen's d uses pooled standard deviations as a means of standardizing data. If the standard deviations between groups under investigated are grossly different, meaning variability between the groups is high, Cohen's d is not the best method for determining effect size. In such a case, Hedge's G, or another method, should be considered when determining effect size.

As a brief side note, Hedge's G often produces more appropriate results in terms of measuring the strength of a relationship when investigating equity data. Such especially holds true when considering hedging strategies in financial markets experiencing extreme uncertainty.

To this end, Cohen's d serves as an indication of the magnitude, or strength, of a statistical effect. The method also works well with other scenarios. However, appropriate investigatory work should be conducted prior to using Cohen's d to ensure the method is appropriate.

Herbert M Barber, Jr, PhD, PhD serves as the Managing Partner and Chief Investment Officer of Xicon Economics. Intersecting the fields of engineering, finance, econometrics, and statistics, Dr. Barber is an expert in financial economics as it relates to the management of random walk theory and navigation of constructs surrounding efficient market hypotheses, especially within assets operating under extreme uncertainty. For over 35 years, he has provided advisory, consulting, and management of large capital investments in the private and public sectors. Additionally, Dr. Barber has published numerous scientific papers in refereed journals. Dr. Barber holds 5 academic degrees, including two research doctorates.

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