MARTIAL CAPITAL WHITEPAPER:

UNDERSTANDING AND MEASURING RISK: A STATISTICAL APPROACH

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One of the many on-line dictionaries defines risk as *"exposure to the chance of injury or loss....The degree of probability of such a loss."*

In other words: understanding the risk of an investment requires that you are given data on the *probability* of gains and losses for that investment. Armed with this information, a potential investor can make a more intelligent decision if this opportunity is right for them.

How does a portfolio manager get such data? From their past performance. While it is true that past performance doesn't guarantee future performance, the evidence of our daily lives tells us that studying the past is one of the best ways we can forecast the future. Historians are certain this is the case.

The way we talk about risk, the way we measure it, is by talking about the "probability" of something occurring. The two most widely used measures of the probability of an event are its Standard Deviation and its Coefficient of Variance (CV).

Standard Deviation

If you ask someone, "How do I measure risk?" they are likely to answer, "Look at the standard deviation of past performance."

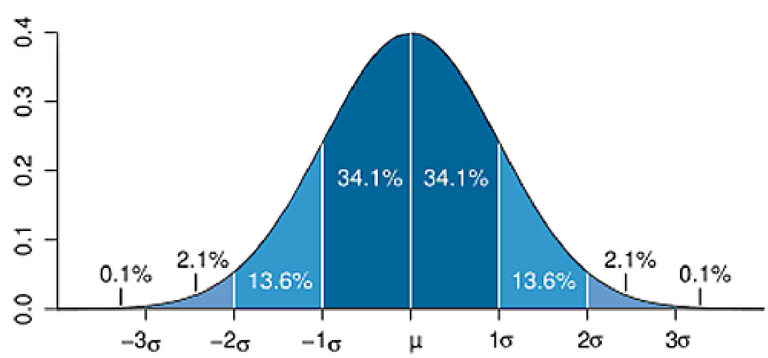
Standard deviation is a number derived by analyzing a set of historical (or experimental) data. If you are using Excel, there is a built-in function that will do it for you. The units of Standard Deviation are the same as the units of data you are analyzing. If your data is the number of minutes to cook dinner, the standard deviation will be in minutes. If you are analyzing rates of return, the units of the standard deviation will be in percentage points. Not "percent" but "percentage points."

You will often see standard deviation written with the Greek letter (lower case) sigma: $\boldsymbol{\sigma}$

If the distribution of the underlying data (your list of monthly returns) is "normally distributed", then 68.27% of the observations will lie within one standard deviation of the mean ("average"). The smaller the standard deviation, the "tighter" the distribution and the less risk there is that the event (returns of a portfolio for example) will be different from the average, i.e. a surprise. A higher standard deviation means there is a great chance the actual return will be different from the average.

Three important notes:

- A smaller standard deviation, **σ**, also means that the actual returns in any given month are less likely to be higher than the average. Some people forget that standard deviation cuts both ways.
- The "68% rule" is only true if the data you're working with is "normal." That's a big "if". A "normal" distribution looks like a bell. It's symmetrical. Unless the shape of the distribution is "normal", the rule doesn't apply. So in most cases, the standard deviation enclosing 68.2% of the observations isn't true.
- The definition of Standard Deviation is based on "expected values". Most people don't understand that and thus let Excel calculate something that is completely erroneous. For example, measuring the set of data points around a mean creates a standard deviation that is only accurate if you're expectation is that the data is going to be a straight line. If, for example, you put the following sequence into Excel {2 4 6 8 10} and ask for the Standard Deviation you'll get 3.61. The practical application of this caution is that if you're using Excel or other off the shelf software to calculate standard deviation, don't apply it to the value of your portfolio, which you hope is going to be going up by 1% a month. Apply it to the monthly gains, which you expect to be flat at 1%.
- A "normal distribution" looks like the following. If the graph of your own returns looks different, don't assume that the traditional inferences about standard deviation will apply to you.



The dark blue is less than one standard deviation from the mean. For a normal distribution, this accounts for 68.2% of the events; while two standard deviations from the mean (medium and dark blue) account for 95.4%; and three standard deviations (light, medium, and dark blue) account for 99.7% of the events.

Measuring Risk between Two Data Sets with Significantly Different Means

There is another case when using the standard deviation will lead you to an erroneous conclusion: when you are comparing investments (a stock, a fund, or a whole portfolio) whose mean returns are significantly different. Example:

	Fund A	Fund B
Mean Return	11.0%	28%
Standard Deviation	8 percentage points	12 percentage points

Does this mean that an investment in Fund A is less risky because the standard deviation is lower?

No really. Take a look at the following; assuming the returns of both investments are normally distributed.

	Fund A	Fund B
Mean Return	11.0%	28%
Standard Deviation	8 percentage points	12 percentage points
68% of the time, the actual returns will be within this range	3% to 19%	16% to 40%

Most people would say the Fund A is more risky when given this additional information. It has a greater chance of wiping out all of its gains then Fund B.

For comparing investments where the means a quite different, the preferred measure is the Coefficient of Variance.

Coefficient of Variance (CV)

The coefficient of variation (CV) is a measure of dispersion of a distribution. It is defined as the ratio of the standard deviation divided by the mean. The CV is a dimensionless number that allows comparison of the variation of populations that have significantly different means. It is often reported as a percentage by multiplying the CV by 100.

	Fund A	Fund B
Mean Return	11.0%	28%
Standard Deviation	8 percentage points	12 percentage points
68% of the time, the actual returns will be within this range	3% to 19%	16% to 40%
Coefficient of Variance (CV)	73%	43%

The CV makes is clear that Fund A has returns which vary more greatly than Fund B, and thus Fund A is the more risky.