

## Standard Deviation, Sigma or $\sigma$

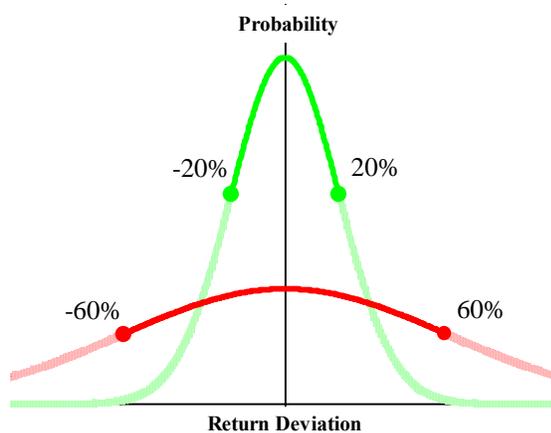
### Introduction

Investors care about investment risk because fluctuations in the value of their investments introduce uncertainty into their future wealth. More plainly, investment risk makes their ability to fund college tuition, pay a mortgage or retire with dignity uncertain.

The range of returns from lowest to highest - or from the 25<sup>th</sup> percentile to the 75<sup>th</sup> percentile - could be used to describe risk but these ranges are not well suited for answering many important questions.

### Standard Deviation, Sigma or $\sigma$

Standard deviation measures dispersion in investment returns.<sup>1</sup> Two distributions of returns are plotted below.



In both distributions, returns near the middle are more likely than larger deviations.  $\frac{2}{3}$ <sup>rds</sup> of the returns under each distribution are bounded by the labeled points. Thus, in one distribution  $\frac{2}{3}$ <sup>rds</sup> of the likely returns are between -20% and +20%. The standard deviation of the returns described by this distribution is 20%.

Similarly, the distribution with points labeled -60% and +60% has a standard deviation of 60% and is therefore more risky. 20% and 60% standard deviations are roughly the risk of a

broadly diversified stock portfolio and of a concentrated investment in a NASDAQ stock.

### How Standard Deviation Is Calculated

The standard deviation of a sample of returns is calculated by first subtracting the average return from each return. Each difference is squared and the squared terms are added up. The resulting sum is divided by the number of returns to get a statistic called variance. Standard deviation is the square root of variance.

The standard deviation we calculate yields valuable information about future risk if the sample of returns we used is similar to the distribution future returns are drawn from.

### $\sigma$ and Risk

Standard deviation is the most useful measure of risk in an investor's portfolio of assets because it provides the best estimate of the likelihood of outcomes that might jeopardize college tuition, mortgage payments, and retirement dreams.

An investment with a standard deviation of 20% has only a 1-in-25 chance of losing more than 20% in one year.<sup>2</sup> An investment with a standard deviation of 60% has a 5 times greater chance of losing more than 20%.

	$\sigma = 20\%$	$\sigma = 60\%$
Probability of Loss		
Greater Than 20%	4.0%	24.9%
Greater Than 40%	0.0%	9.9%

### Conclusion

Standard deviation is the correct measure of risk for investors' entire portfolios. Presentations of standard deviation can be tailored to inform investors of varying levels of sophistication. It is simple to calculate and interpret and is ubiquitous in the investment management literature and in the brokerage industry.

June 15, 2005

<sup>1</sup> A companion note deals with beta and another deals with risk measures tailored specific to measure the risk of loss.

<sup>2</sup> Expected return is assumed to be 10% and the returns are assumed to be log-normally distributed.