

MEASURING RISK

WHAT WILL YOU LEARN?

- ▶ What is risk?
- ▶ How do you develop a measure of risk?

HOW DO WE DEVELOP A MEASURE OF RISK?

- ▶ Start with a probability distribution of possible outcomes.
- ▶ Suppose there are three possible outcomes for the share price of XYZ stock.

HOW DO WE DESCRIBE A DISTRIBUTION OF RETURNS?

- ▶ Central tendency
 - ▶ We will use the expected value as a measure of central tendency.
 - ▶ The expected value is a probability weighted average of the outcomes.
- ▶ Standard deviation (or variance)
 - ▶ We'll use the standard deviation as the measure of the dispersion for a distribution.

MEASURING RISK

- ▶ Variance is the expected value of squared deviations from the mean.
- ▶ Standard deviation is the square root of variance.
- ▶ The higher the variability or the volatility of the outcomes is, the higher will be the squared deviations.

VARIANCE AS A MEASURE OF RISK

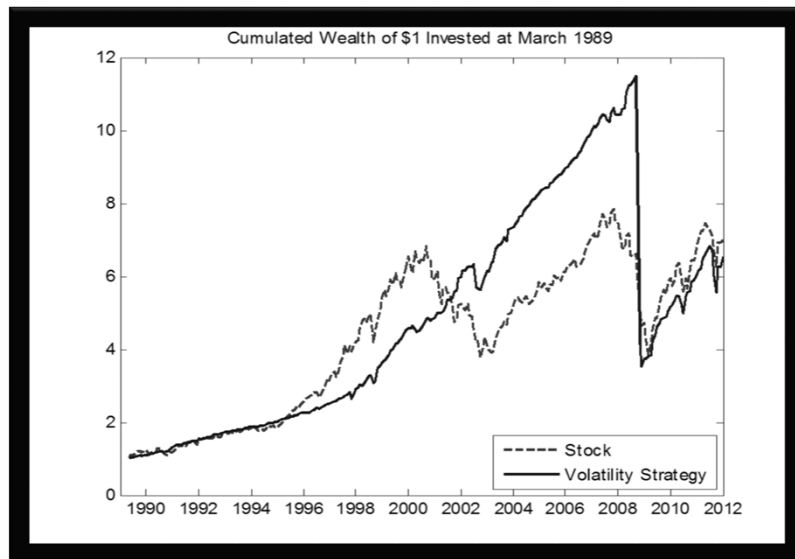
- ▶ Variance and standard deviation provide one measure of uncertainty – or the risk – in outcomes.

ALTERNATIVE RISK MEASURES

WHAT WILL YOU LEARN?

- ▶ What other measures can we use to characterize returns?
- ▶ What is skewness? What does it measure?
- ▶ What is kurtosis? What does it measure?

VOLATILITY STRATEGY VS. S&P 500

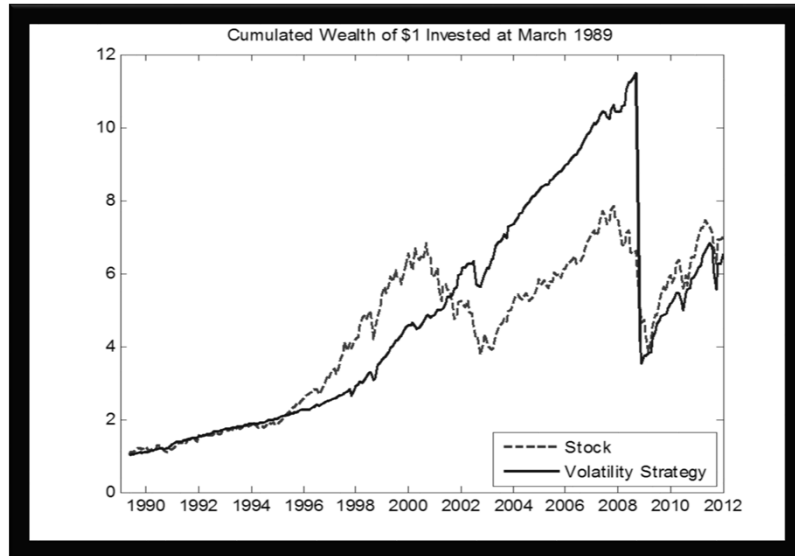


Source: Ang (2014), *Asset Management*, pg. 36

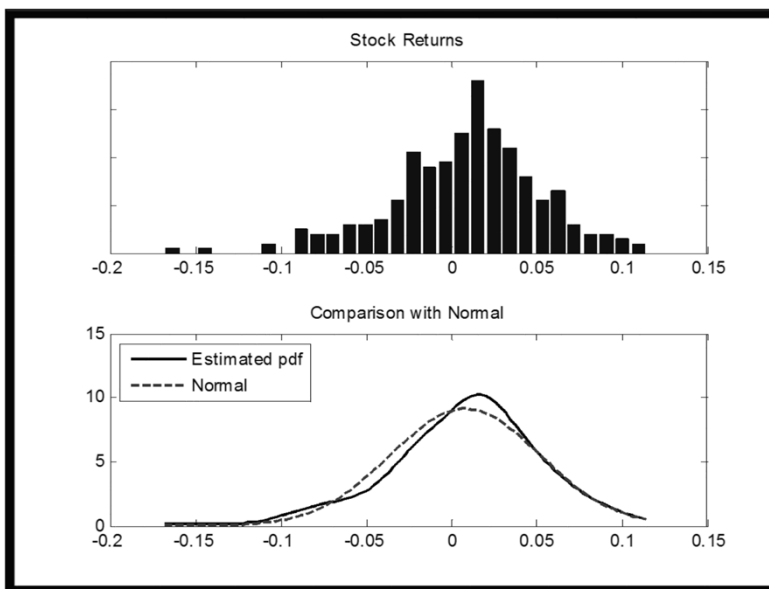
VOLATILITY STRATEGY VS. S&P 500

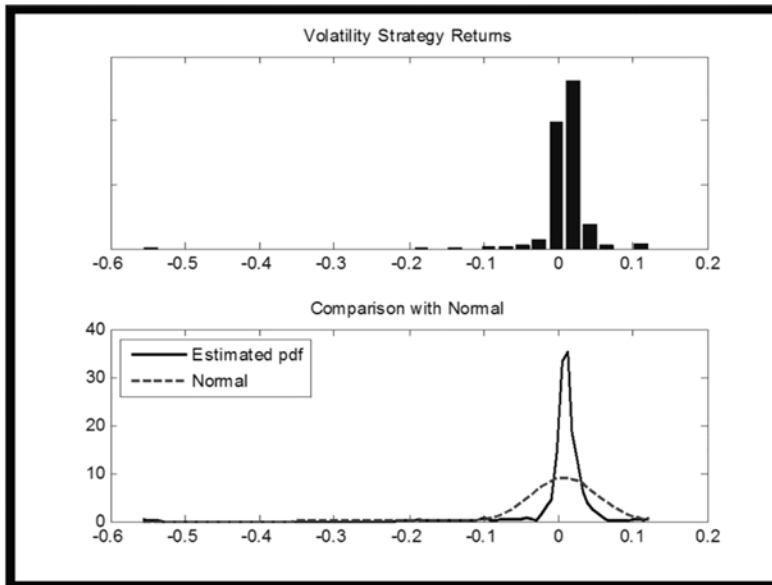
- Volatility strategy is an investment strategy that collects a premium during stable periods, but has large losses during volatile times.
 - It's like selling against a catastrophic event.

VOLATILITY STRATEGY VS. S&P 500



Source: Ang (2014), *Asset Management*, pg. 36





VOLATILITY STRATEGY VS. S&P 500

	Volatility strategy	S&P 500
Mean	9.9%	9.7%
Standard deviation	15.2%	15.1%
Skewness	-8.3	-0.6
Kurtosis	104.4	4.0

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- ▶ Skewness is a measure of asymmetry.
 - ▶ Normal distribution has a skewness measure of zero.
 - ▶ When a distribution is skewed to the left, the extreme negative values dominate and the measure is negative.
 - ▶ When a distribution is skewed to the right, the extreme positive values dominate and the measure is positive.
 - ▶ When the distribution is skewed to the left, the standard deviation will underestimate risk.

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- ▶ Kurtosis measure the degree of fat tails.
 - ▶ Normal distribution has a kurtosis measure of zero.
 - ▶ Fat tails implies there is greater probability mass in extreme events in the tails.
 - ▶ Again, standard deviation will underestimate the likelihood of extreme events.

SUMMARY

- ▶ Skewness and kurtosis are two additional measures that we can use to characterize the return distribution.
- ▶ Skewness measures the degree of asymmetry.
- ▶ Kurtosis measures the degree of fat tails – that is, the likelihood of extreme events.

SUMMARY

- ▶ The dispersion of possible outcomes around the mean is a measure of uncertainty.
- ▶ Variance and standard deviation provide one measure of risk.

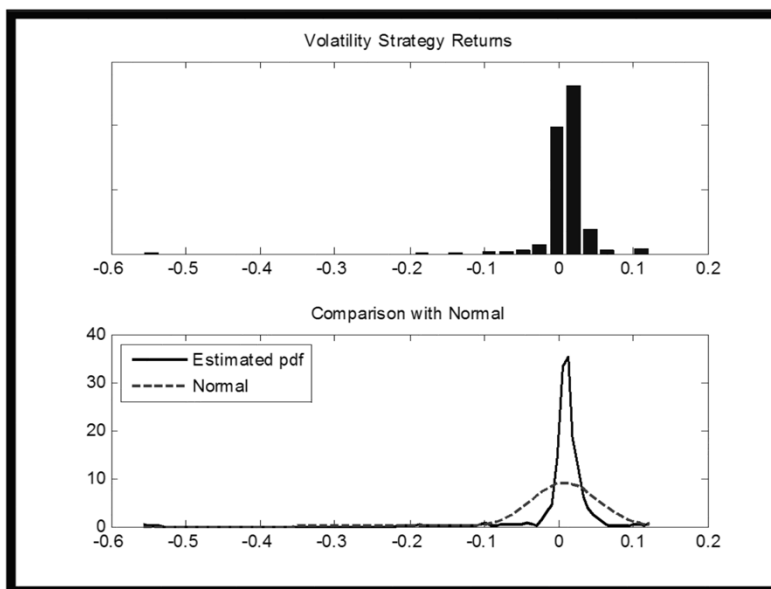
MORE ON MEASURING RISK AND ALTERNATIVE RISK MEASURES

WHAT WILL YOU LEARN?

- ▶ When is volatility not a good risk measure?
- ▶ What is value-at-risk (VaR)?
- ▶ What is expected shortfall (ES)?

VOLATILITY AS A RISK MEASURE

- Volatility is not appropriate risk measure for investment strategies with extreme crash risk.



VALUE-AT-RISK MEASURE

- ▶ Value-at-risk (VaR) is another measure of risk that attempts to capture tail risk (non-normality).
- ▶ It measures the maximum loss with a certain confidence.
- ▶ For example, VaR is the most you can lose with a 95% or 99% confidence.

EXAMPLE

- ▶ A hedge fund has a one-day 95% VaR of \$10 million if the probability of losing at most \$10 million is 95%.

HOW DO YOU ESTIMATE VALUE-AT-RISK?

- ▶ You can estimate the VaR by sorting past returns and then finding the return that has 5% worse days, and 95% better days.
- ▶ This is the VaR since – if history repeats yourself – you will lose less than this number with 95% confidence.

EXPECTED SHORTFALL (ES)

- ▶ The VaR doesn't really tell us how *much* you lose if you do lose.
- ▶ Expected shortfall is another risk measure that captures the magnitude of tail losses.
- ▶ Expected shortfall is the expected loss given that you are losing more than the VaR.

SUMMARY

- ▶ Volatility is not an appropriate risk measures when there is an extreme event risk.
- ▶ Value-at-risk (VaR) and expected shortfall (ES) are two additional risk measures that can be used to capture the likelihood of tail risk and the magnitude of losses if indeed a tail event materializes.