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.

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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

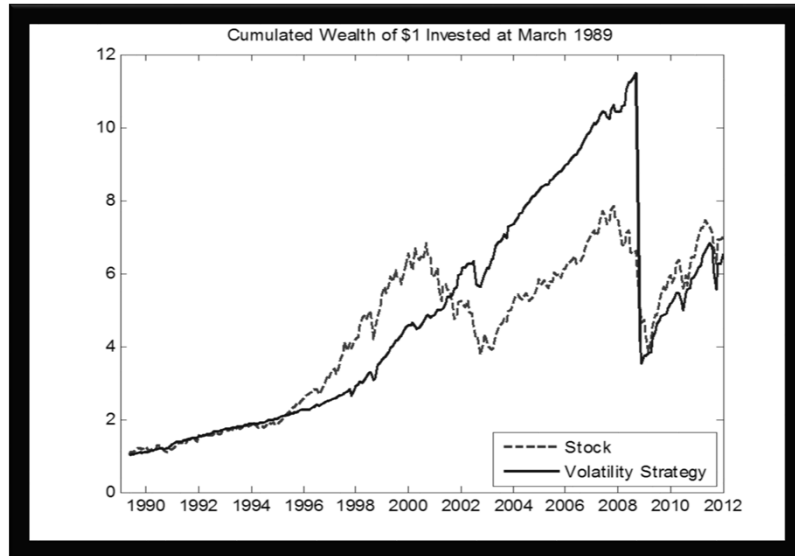Cumulated Wealth of $1 Invested at March 1989
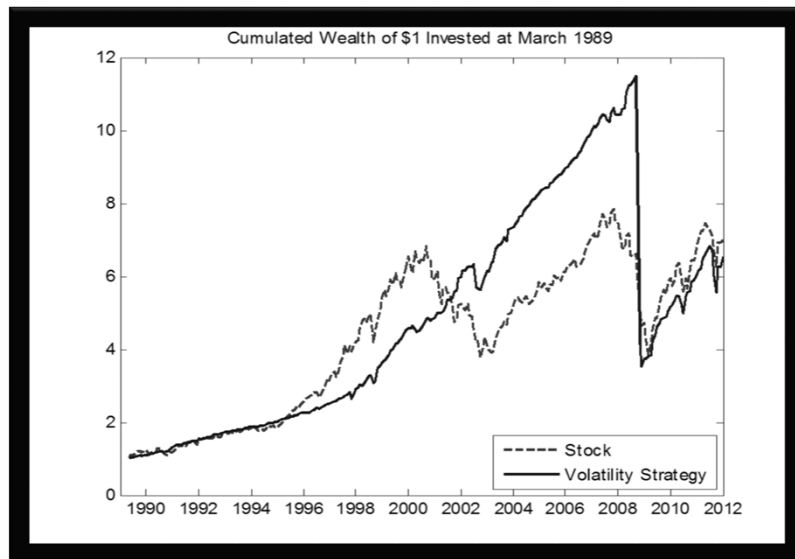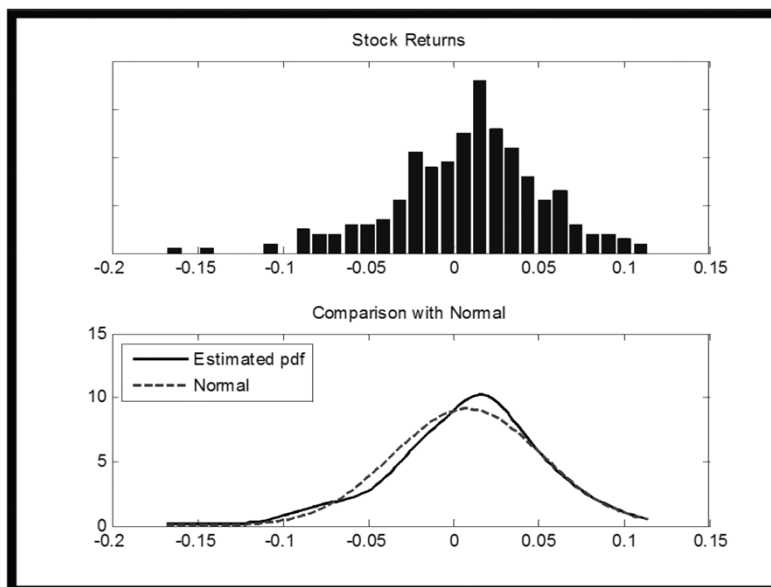
Source: Ang (2014), <u>Asset Management</u>, pg. 36

VOLATILITY STRATEGY VS. S&P 500
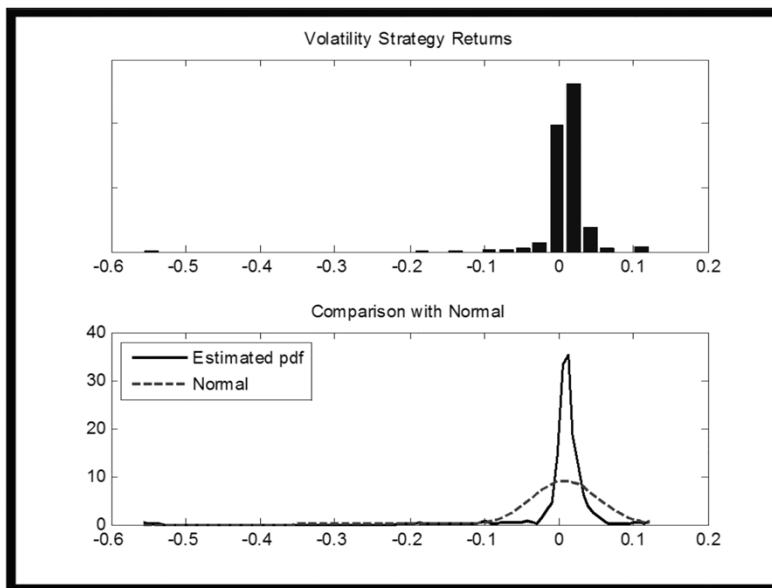
▸ Volatility strategy is an investment strategy that collects a premium during stable periods, but has large losses during volatile times.

  ▸ It's like selling against a catastrophic event.

VOLATILITY STRATEGY VS. S&P 500

Cumulated Wealth of $1 Invested at March 1989

- - - - - Stock
——— Volatility Strategy

Source: Ang (2014), <u>Asset Management</u>, pg. 36

Stock Returns

Comparison with Normal

——— Estimated pdf
- - - - - Normal

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

VOLATILITY STRATEGY VS. S&P 500

	Volatility strategy	S&P 500
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Kurtosis	104.4	4.0

▸ 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.

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

▸ 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.
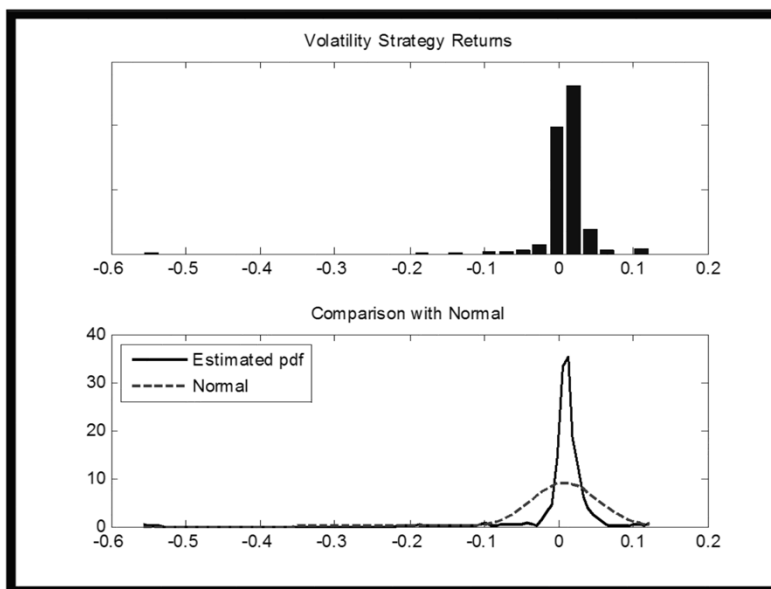- Variance and standard deviation provide one measure of risk.

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.