

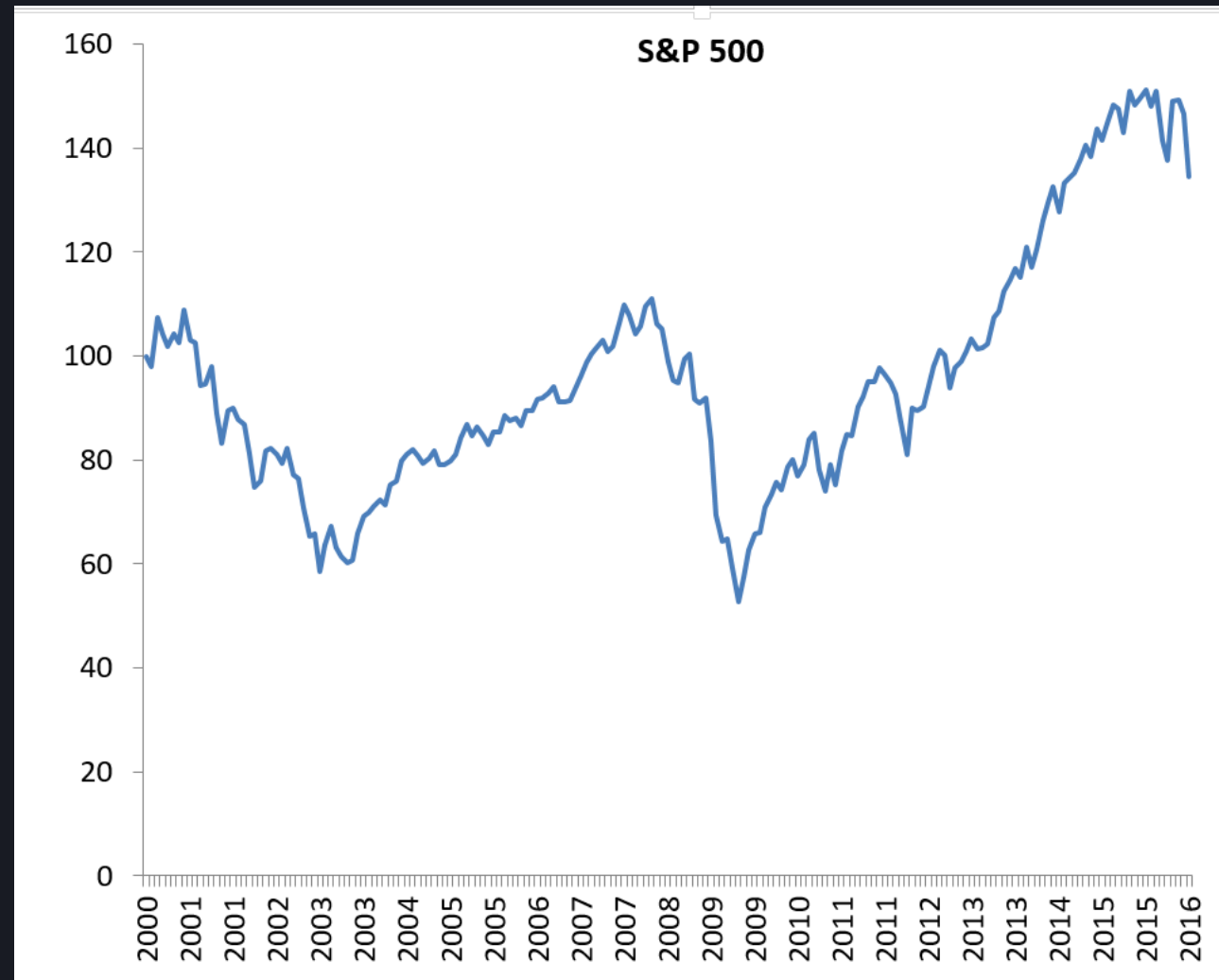
# VaR

- VAR in finance means two things, variance and “value at risk” but when the A isn’t capitalized, it means value at risk
- Invented after stock market crash of 1987
- Value at risk is usually quoted in units of \$ for a given probability and time horizon
- 1% one-year VaR of \$10 million means 1% chance that a portfolio will lose \$10 million in a year

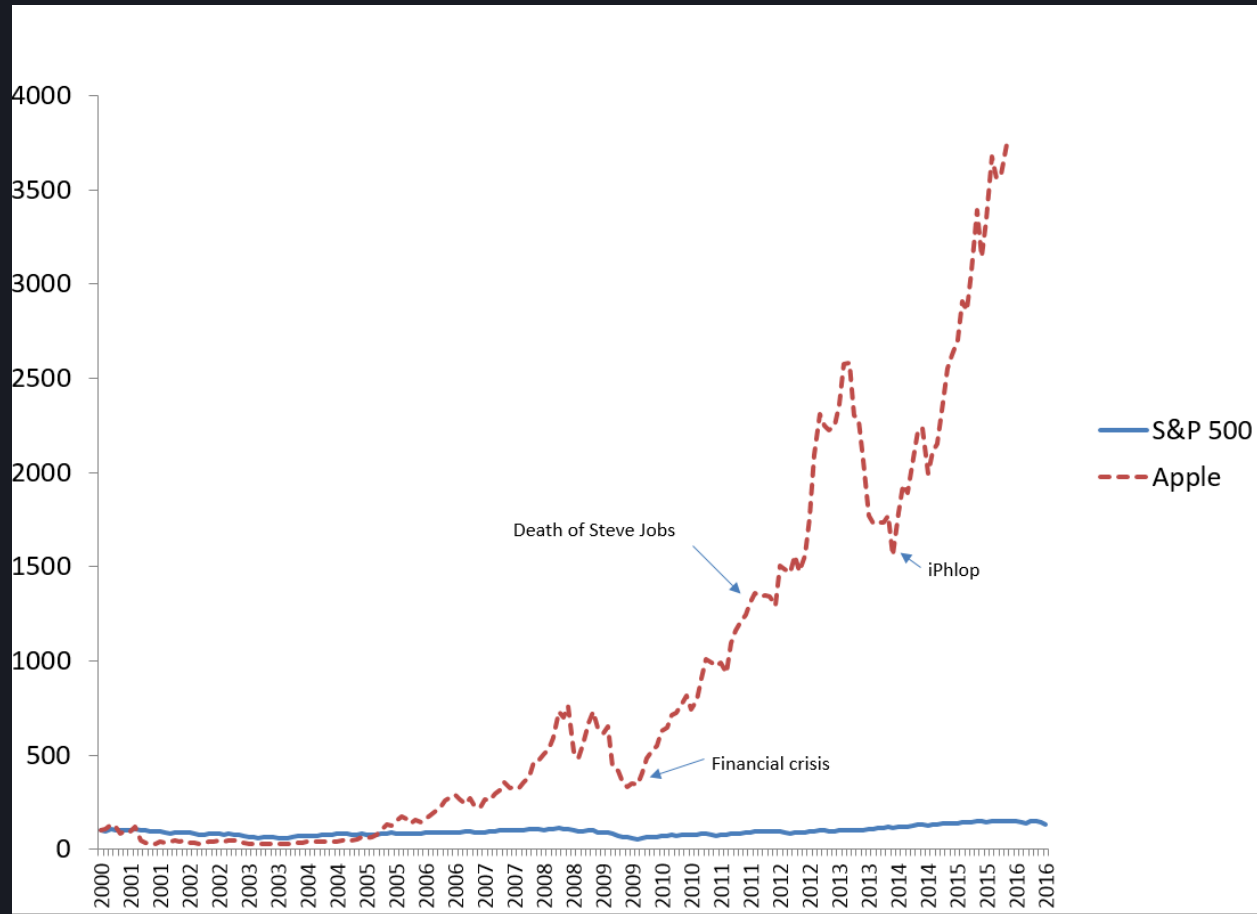
# Stress Tests

- Originally, term referred to a medical procedure to test for cardiovascular fitness
- OFHEO started testing firms' ability to withstand economic crisis before the 2008 crisis, failed.
- Dodd Frank Act 2010 requires the Federal Reserve to do annual stress tests for nonbank financial institutions it supervises for at least three different economic scenarios
- European Banking Authority, created 2011
- UK, China, etc.
- Critics of stress tests such as Anat Admati find them inadequate.

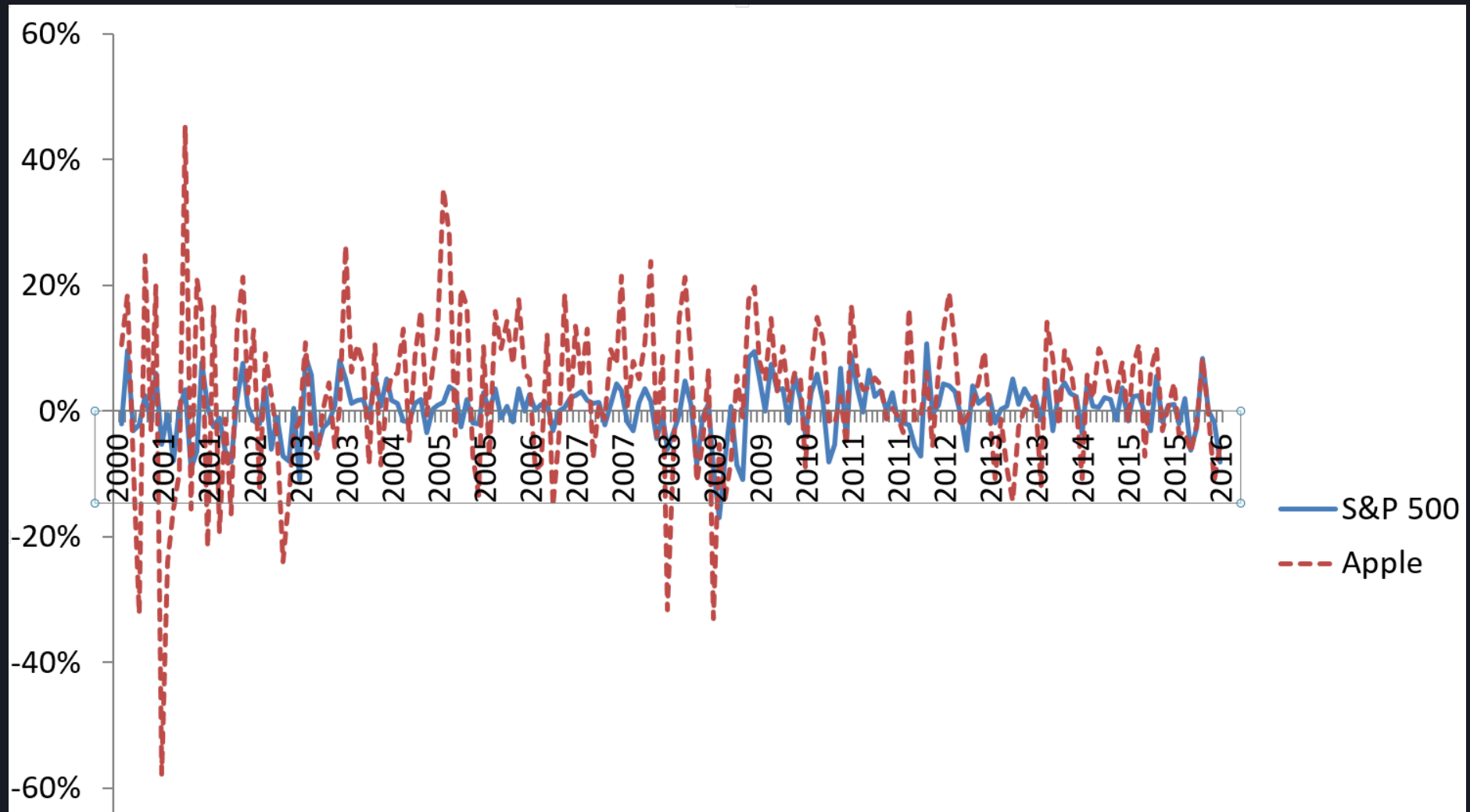
# Stock Market Level, 2000-2016, 2000=100



# Apple, Inc. and S&P 500 Monthly Adjusted Price 2000-2016, 2000=100



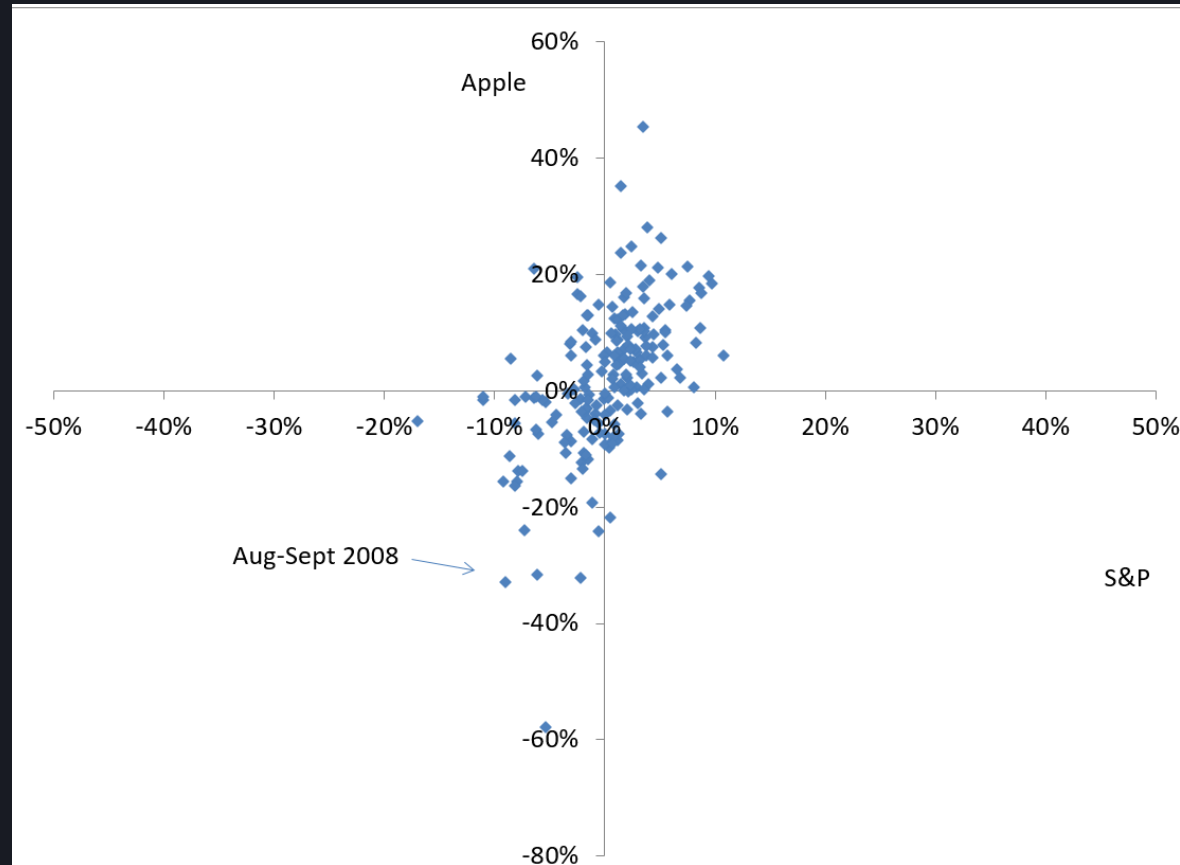
# Apple, Inc. and S&P 500 Monthly Returns, 2000-2016



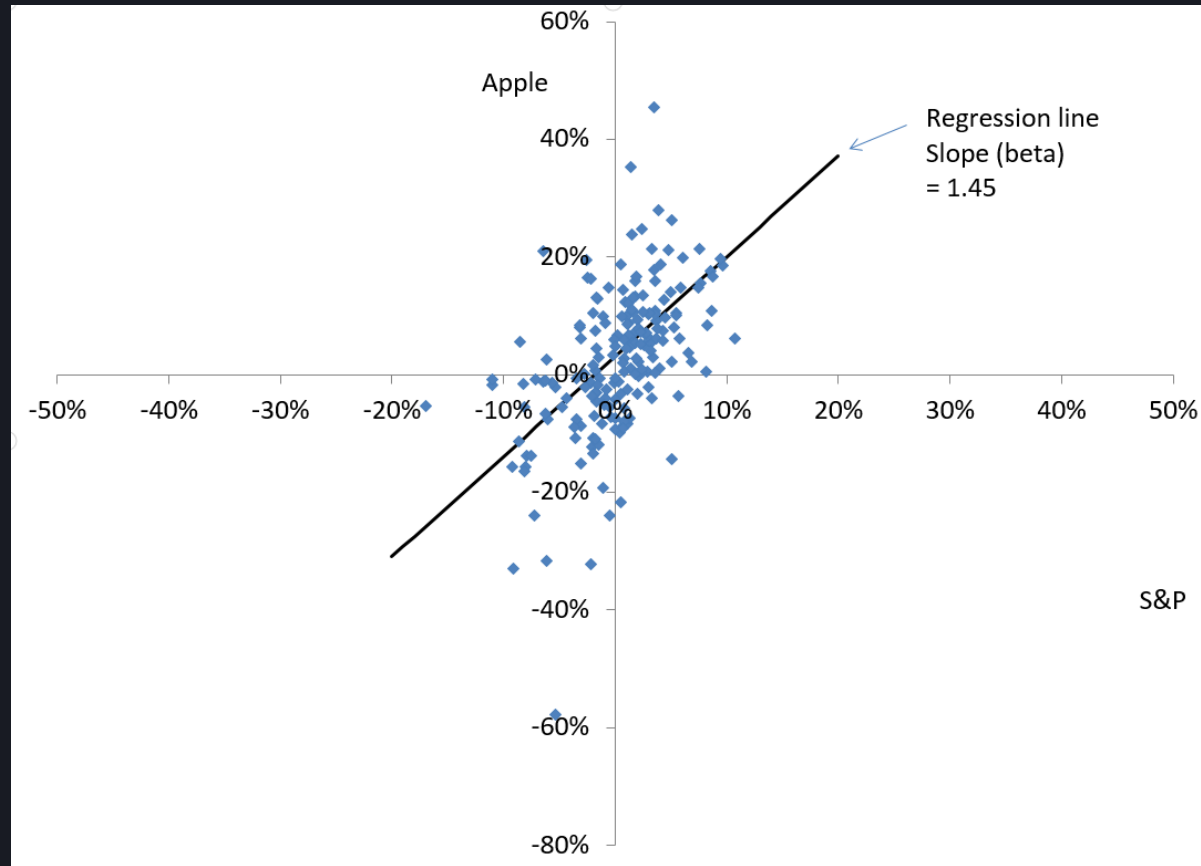
# Variance of Apple vs Variance of S&P500

- Standard deviation of Apple capital gain in decade shown is 12.8% a month (not annualized) (arithmetic mean 3.47% a month, geometric mean 2.65% a month)
- $1.0347^{123}=65$ ,  $1.0265^{123}=25$
- Standard deviation of S&P 500 return in decade shown is 4.7% (arithmetic mean capital gain mean 0.01%, geometric mean - 0.16% a month, meaning we've lost money)

# Scatter, Apple vs S&P 500 Returns Monthly Feb 2000-Jan 2016



# Same Scatter with Regression Line





# Beta

- The CAPM implies that the expected return on the  $i$ th asset is determined from its beta
- Beta ( $\beta_i$ ) is the regression slope coefficient when the return on the  $i$ th asset is regressed on the return on the market
- Fundamental equation of the CAPM:

$$r_i = r_f + \beta_i(r_m - r_f)$$

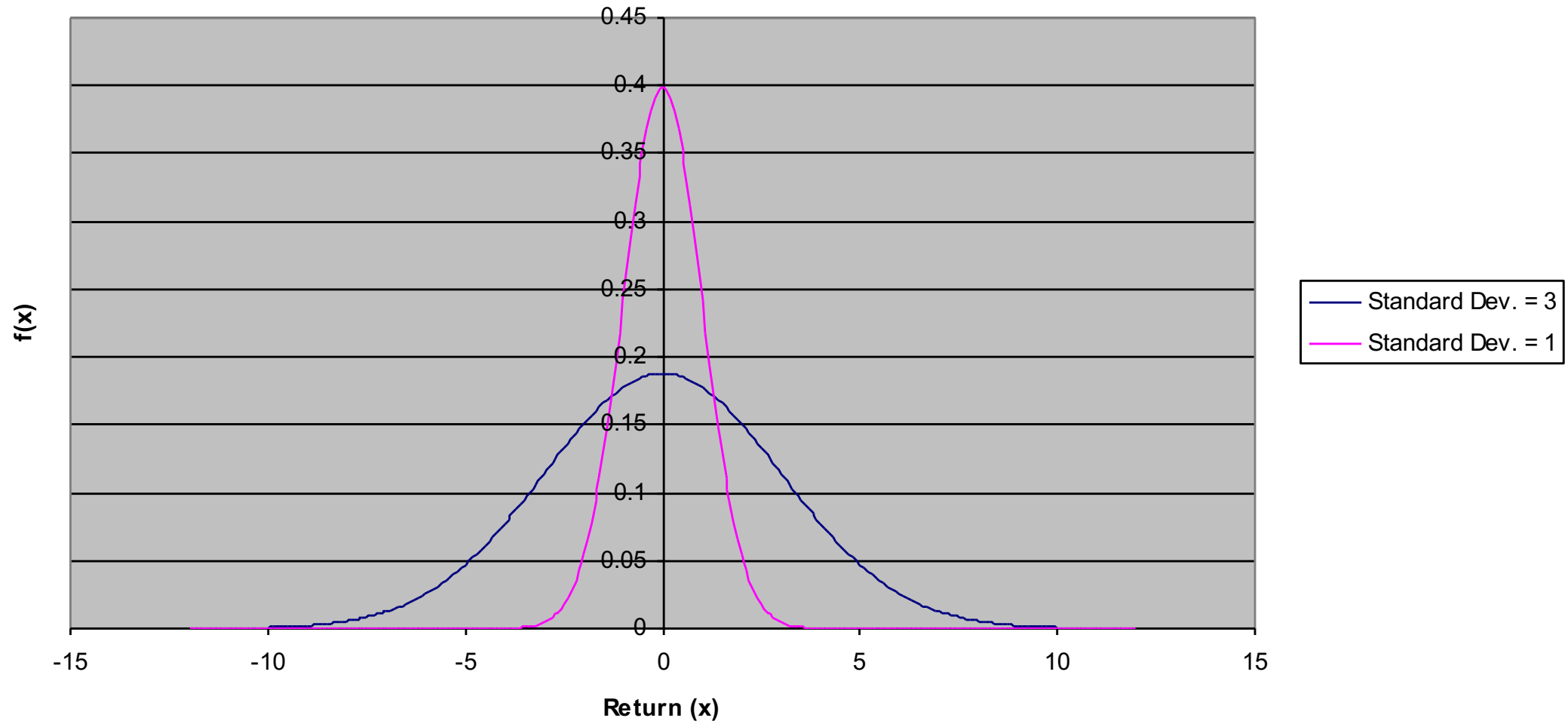
# Market Risk versus Idiosyncratic Risk

- By construction, the residuals of error terms in a regression are uncorrelated with the fitted or predicted value
- So, the variance of the return of a stock is equal to its beta squared times the variance of the market return (systematic risk) plus the variance of the residual in the regression (idiosyncratic risk)

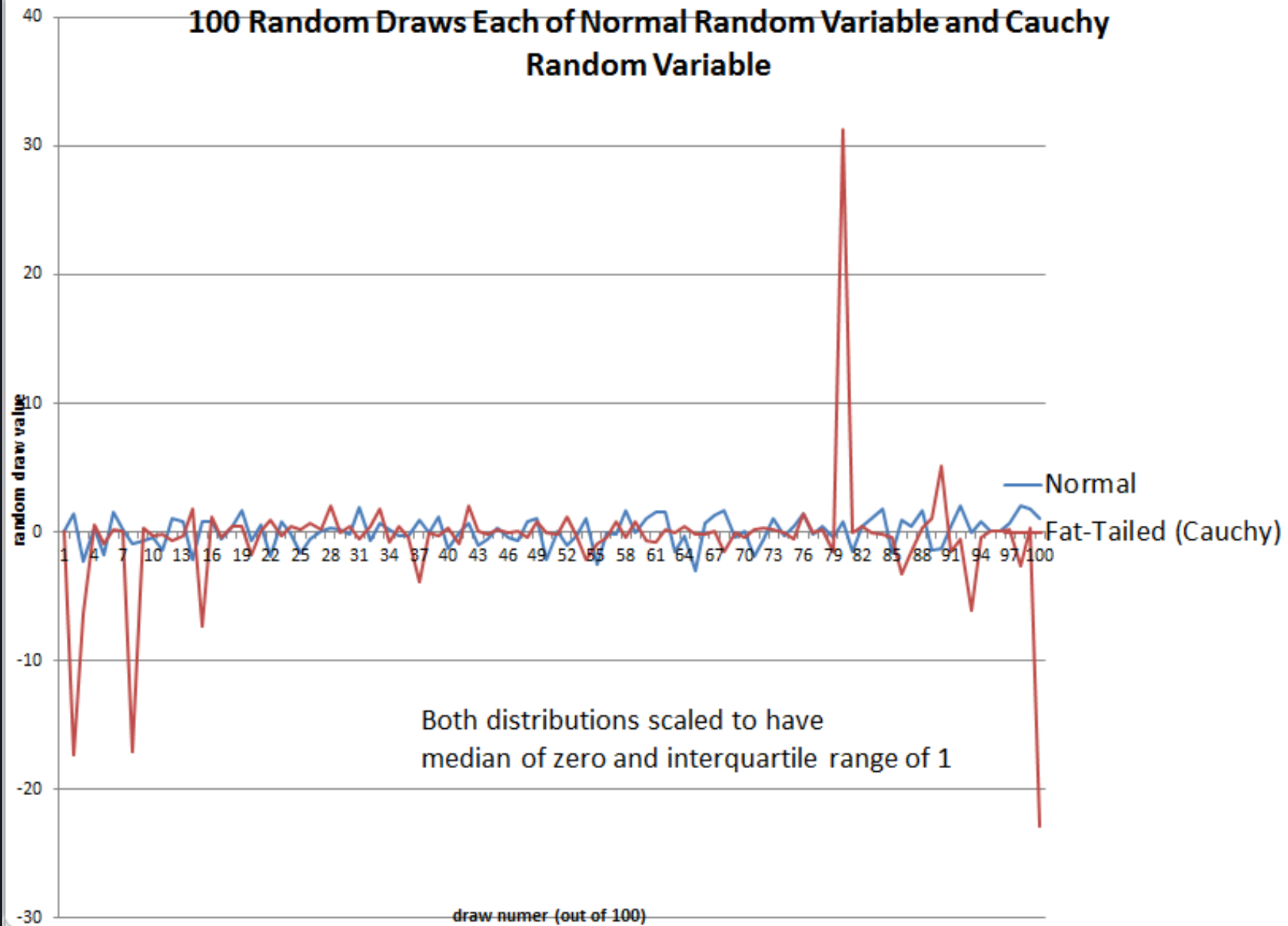
# Joe McNay

- The Class of 1954 gave \$370,000 for Yale at its 25<sup>th</sup> anniversary (in 1979) but asked Joe McNay of Essex Investment Management to invest it for 25 years. They refused to let Yale investments handle it (pre-Swensen)
- In 2004, they presented it to Yale, now worth \$90 million, 24.6% a year return geometric
- He invested in Walmart and Home Depot and Internet
- They got special dispensation from the federal government so that this trust did not need to give away 5% a year
- 1.8% a month geometric

Normal Distribution with Zero Mean



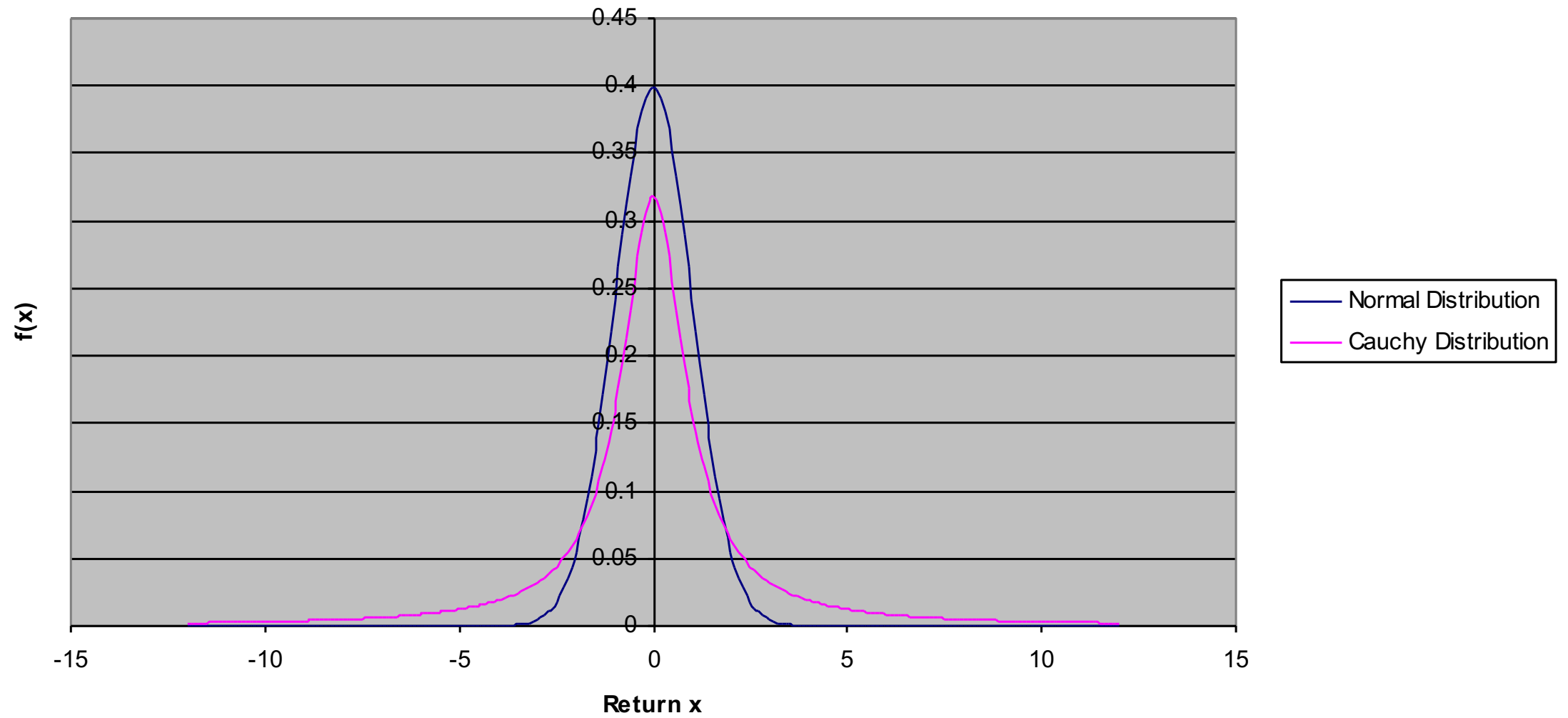
## 100 Random Draws Each of Normal Random Variable and Cauchy Random Variable



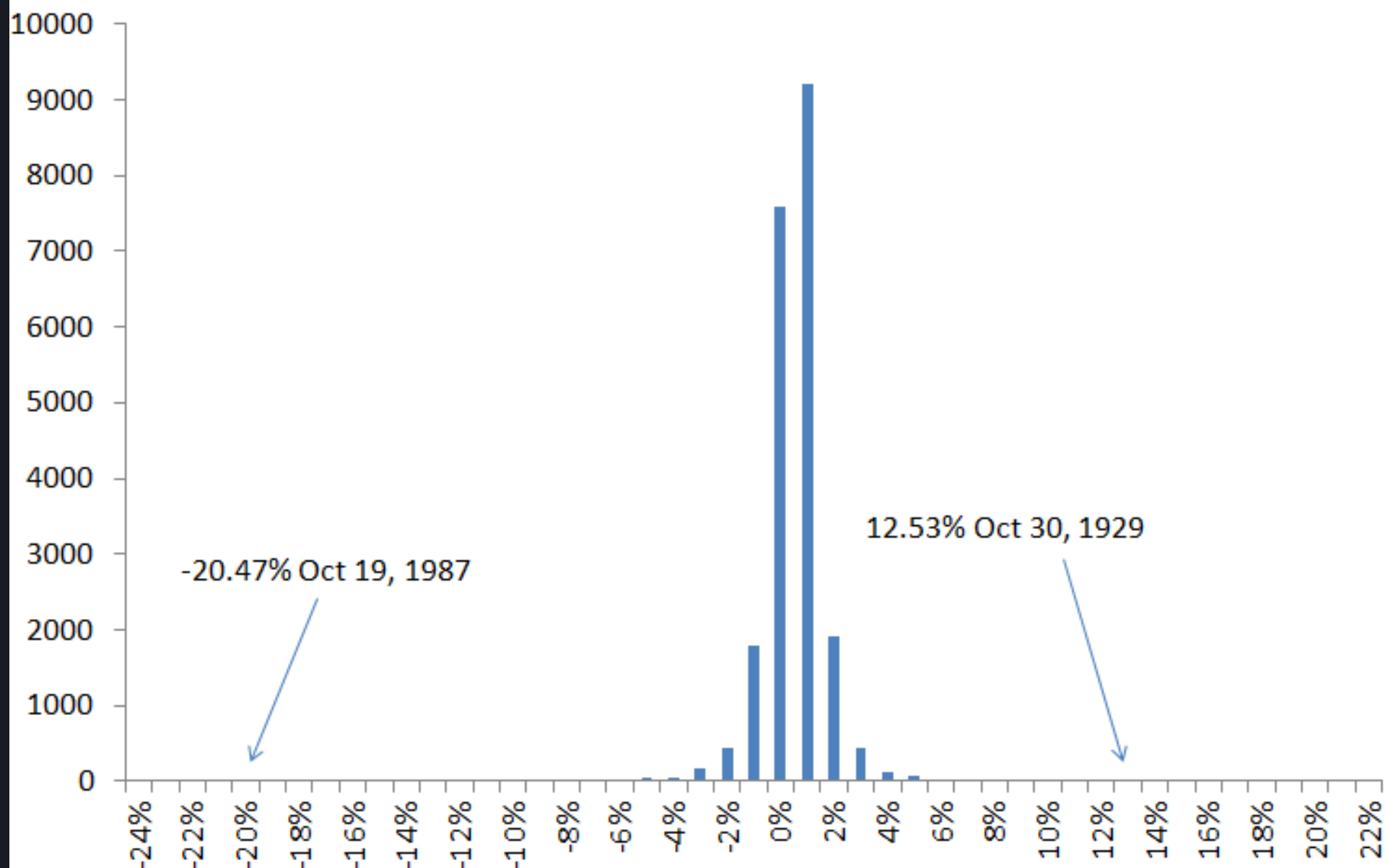
# Central Limit Theorem

- Averages of a large number of independent identically distributed shocks (whose variance is finite) are approximately normally distributed
- Can fail if the underlying shocks are fat tailed
- Can fail if the underlying shocks lose their independence

Normal Versus Fat Tailed Distributions



**Histogram of Daily Stock Price Changes since 1928**





# Outliers

- Normal distribution with same mean and standard deviation as the histogram shown has a probability of a drop greater than 20% equal to  $3 \times 10^{-71}$