

## Lecture 2: Risk and Financial Crises

Economics 252, Spring 2011

Prof. Robert Shiller, Yale University

## Return

- $Return_t = \frac{Price_{t+1} - Price_t + Dividend_t}{P_t}$
- $Gross\ Return = 1 + Return$

## Expected Value, Mean, Average

$$E(x) = \mu_x = \sum_{i=1}^{\infty} \text{prob}(x = x_i) x_i$$

$$E(x) = \mu_x = \int_{-\infty}^{\infty} f(x) x dx$$

$$\bar{x} = \sum_{i=1}^n x_i / n$$

$$G(x) = \left( \prod_{i=1}^n x_i \right)^{1/n}$$

## Variance and Standard Deviation

$$\text{var}(x) = \sum_{i=1}^n \text{prob}(x = x_i)(x_i - \mu_x)^2$$

$$s_x^2 = \sum_{i=1}^n (x_i - \bar{x})^2 / n$$

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## Covariance

$$\text{cov}(x, y) = \sum_{i=1}^n (x - \bar{x})(y - \bar{y}) / n$$

## Correlation

- A scaled measure of how much two variables move together
- $-1 \leq \rho \leq 1$

$$\rho = \text{COV}(x, y) / (s_x s_y)$$

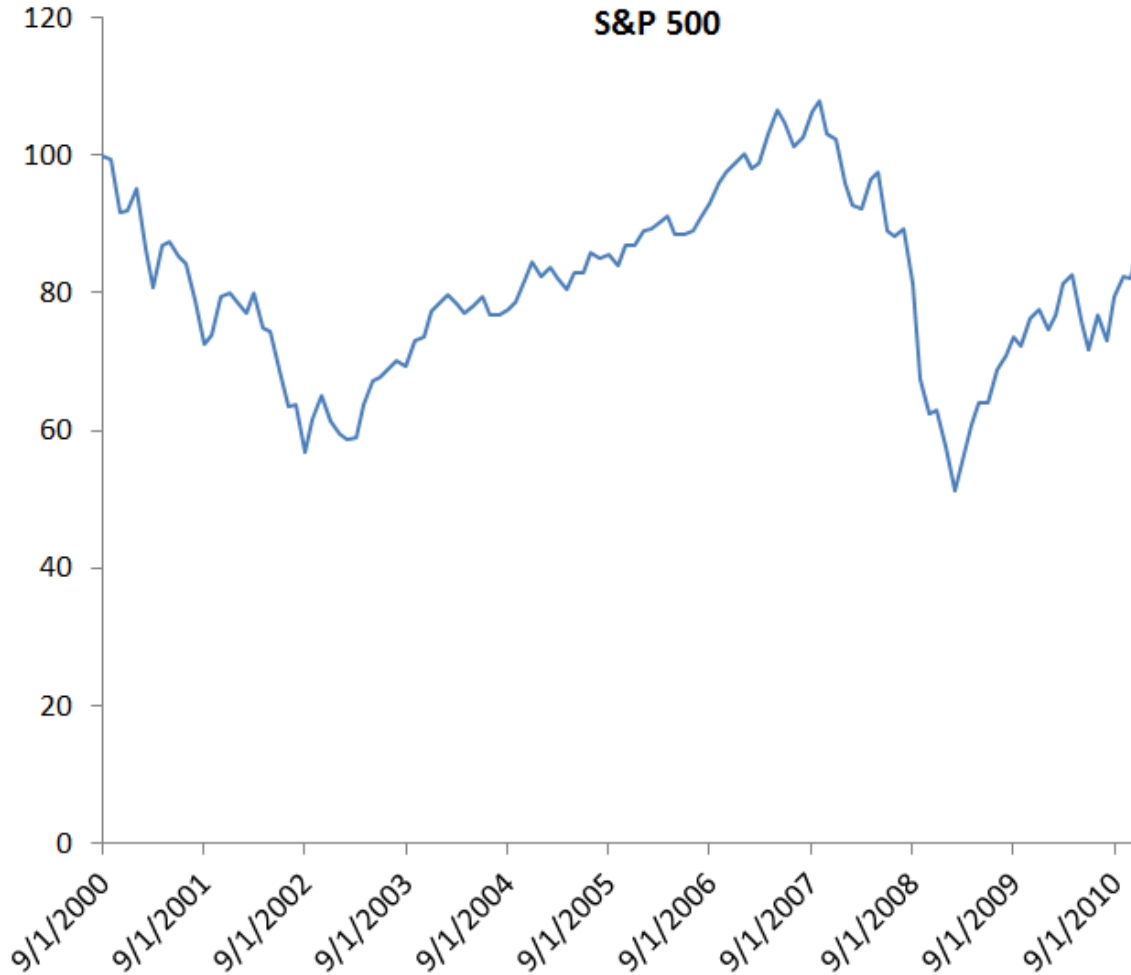
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## Variance of Sum

- $\text{var}(x + y) = \text{var}(x) + \text{var}(y) + 2\text{cov}(x, y)$

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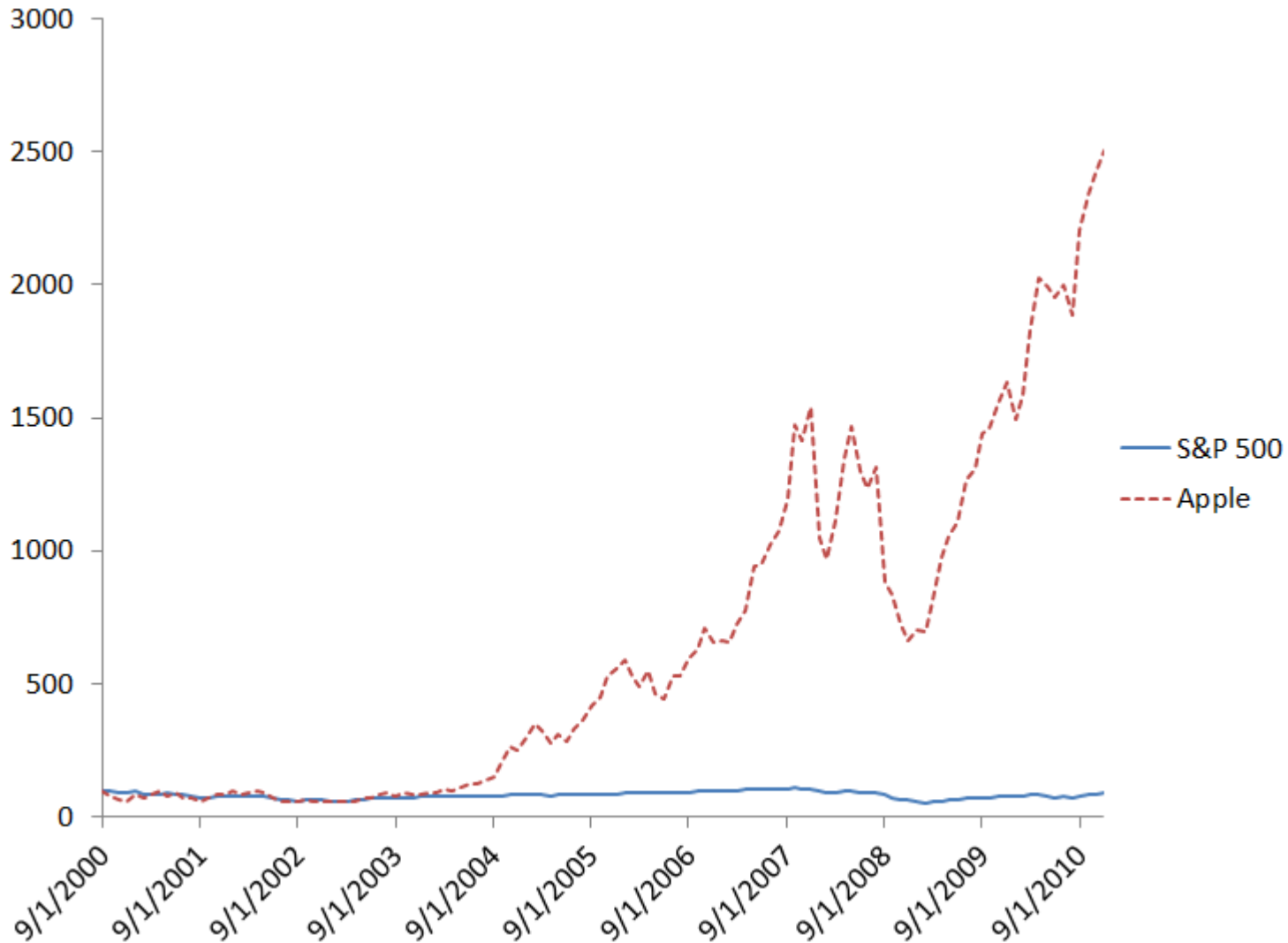
# Stock Market Level, 2000-2010, 2000=100





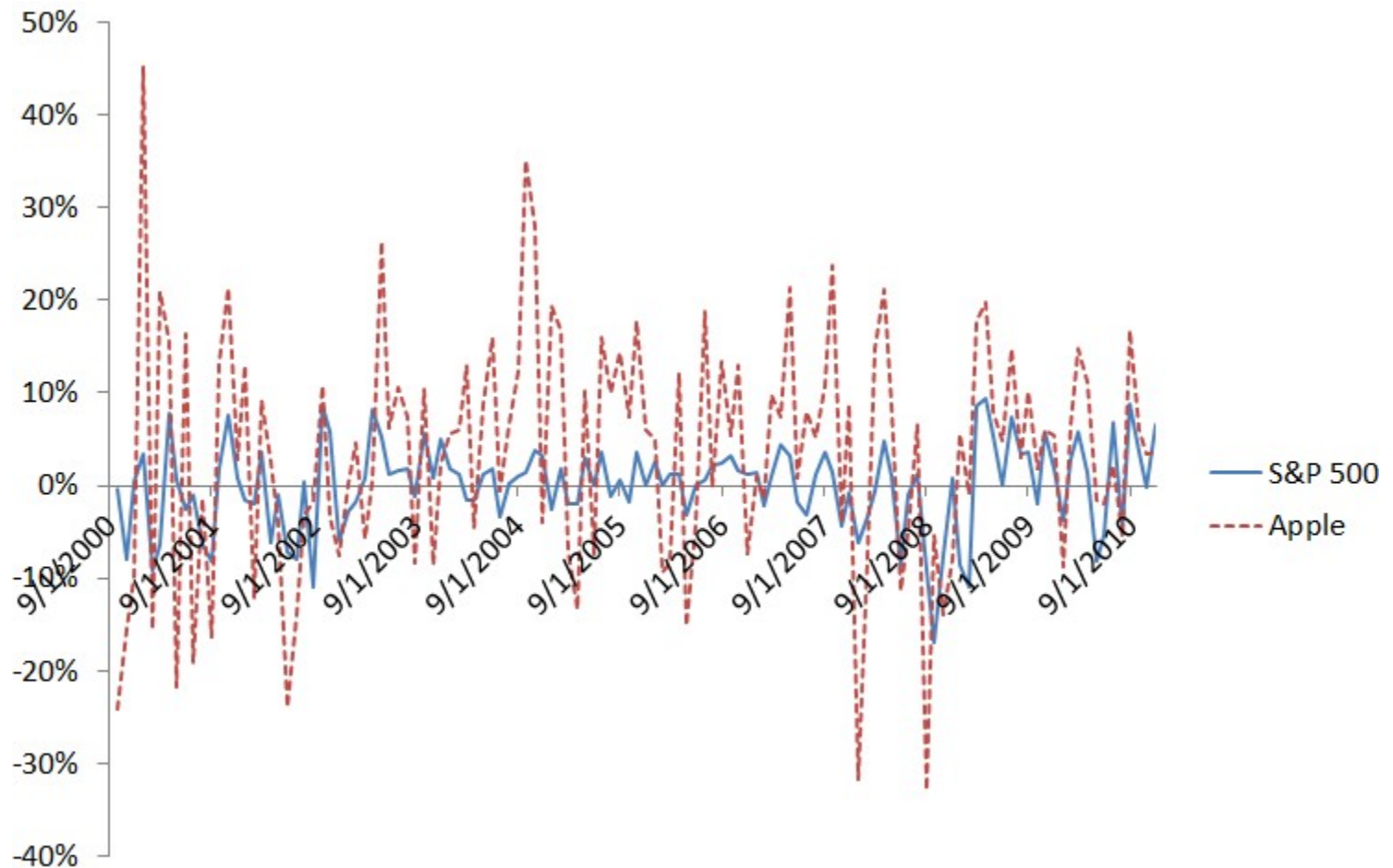
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## Apple, Inc. and S&P 500 Monthly Adjusted Price First Decade of 2000s. 2000=100



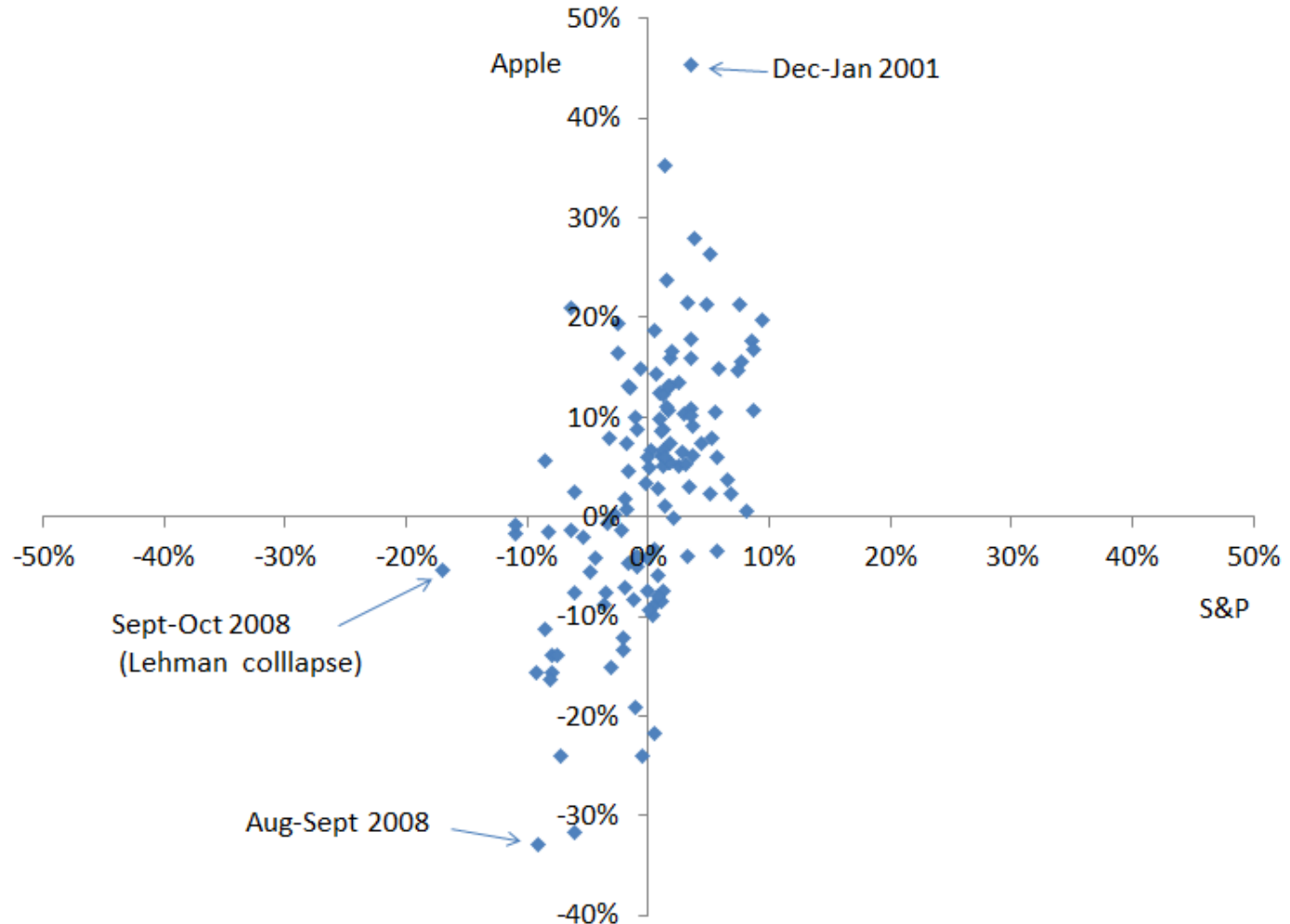
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## Apple, Inc. and S&P 500 Monthly Returns, First Decade of 2000s



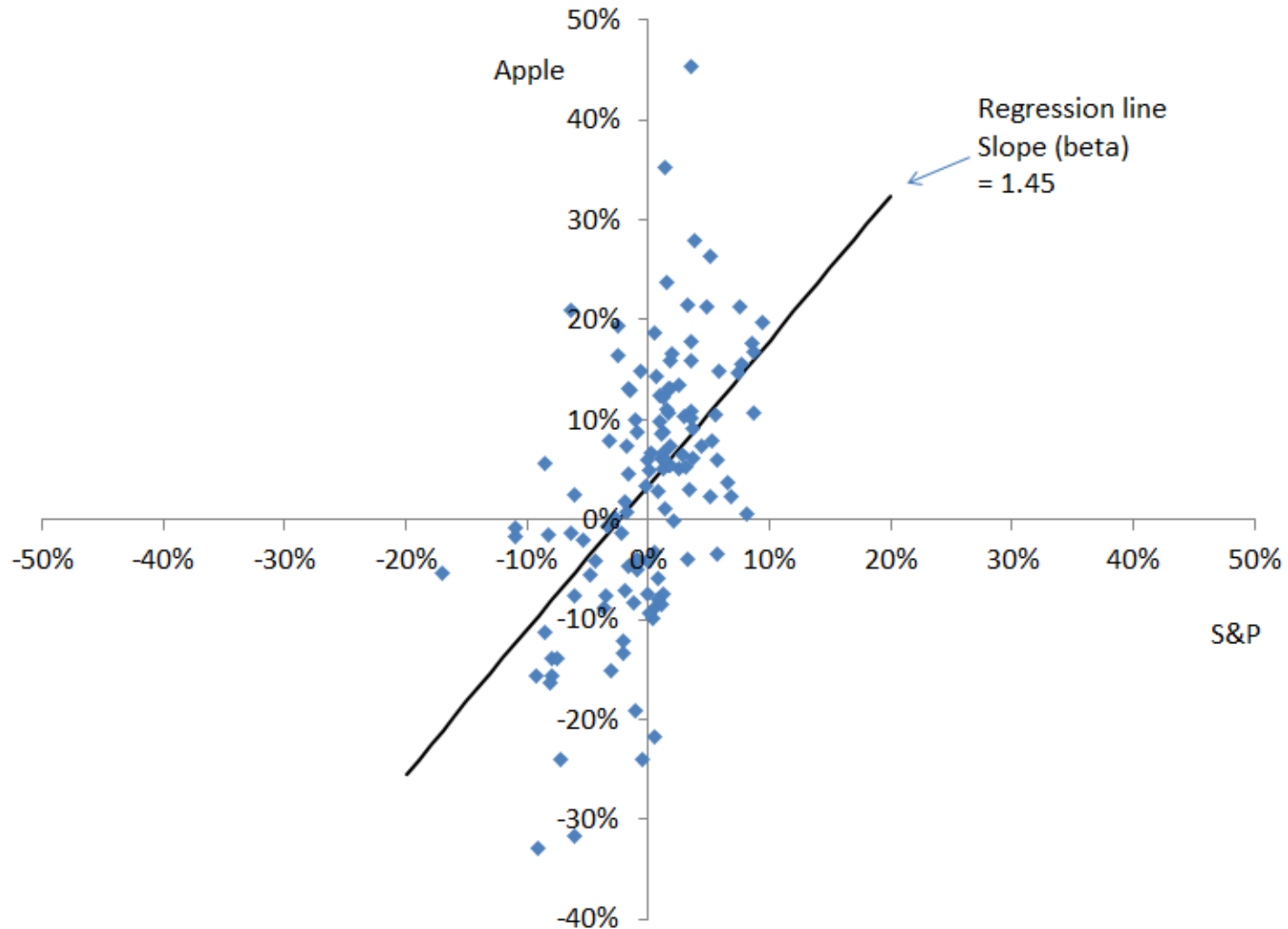
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## Scatter, Apple vs S&P 500



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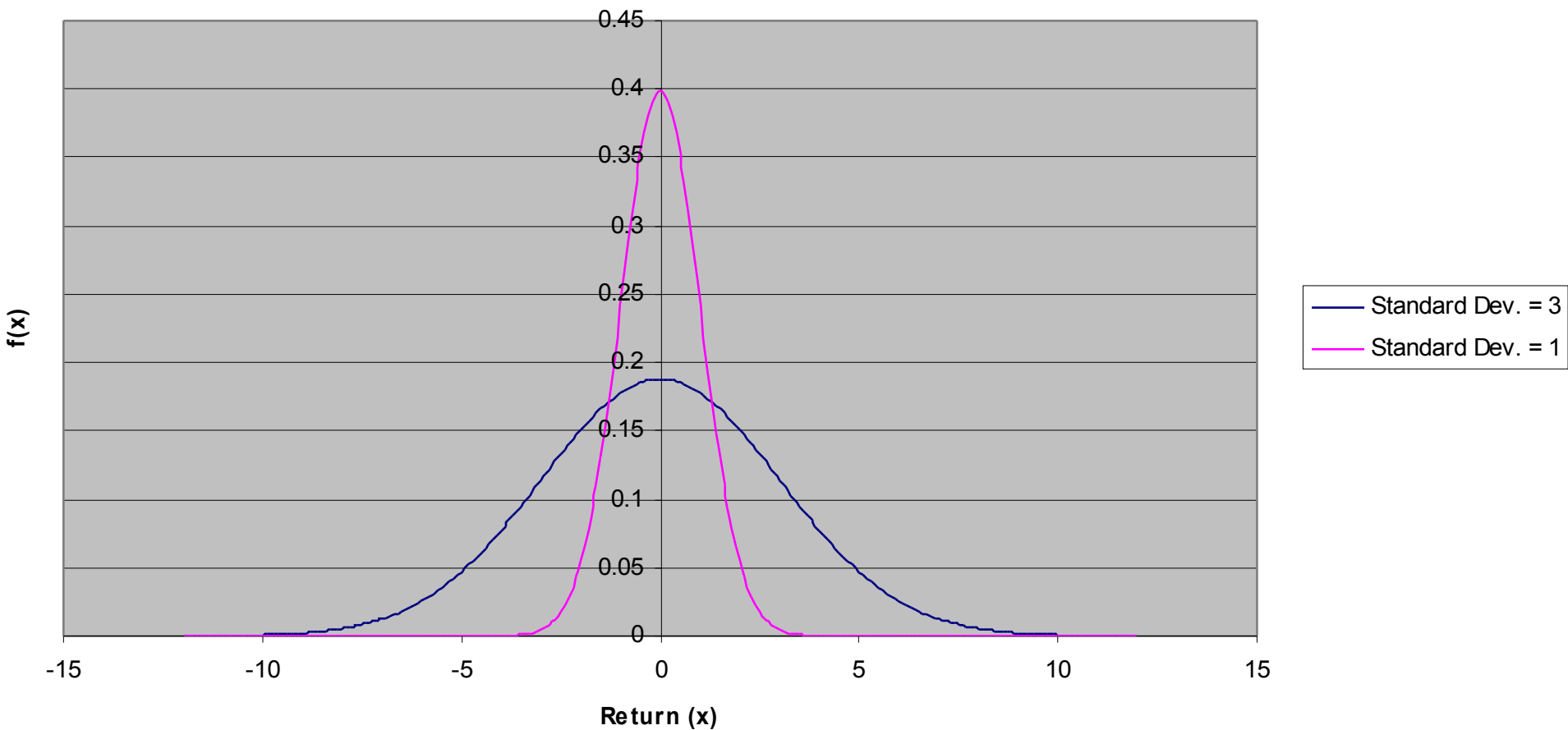
## Same Scatter with Regression Line



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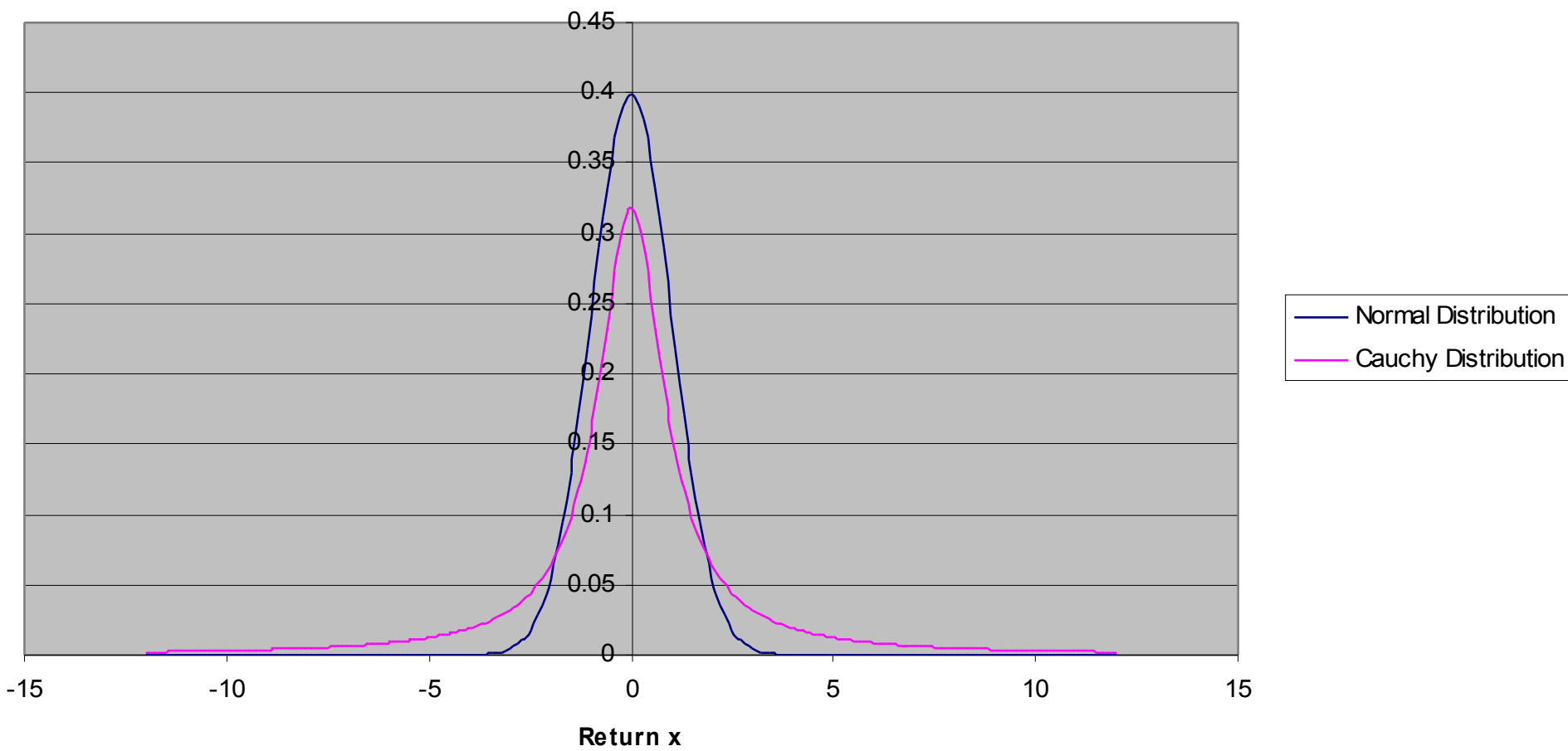
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## Normal Distribution with Zero Mean



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## Normal Versus Fat Tailed Distributions



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## Histogram of Daily Stock Price Changes since 1928

