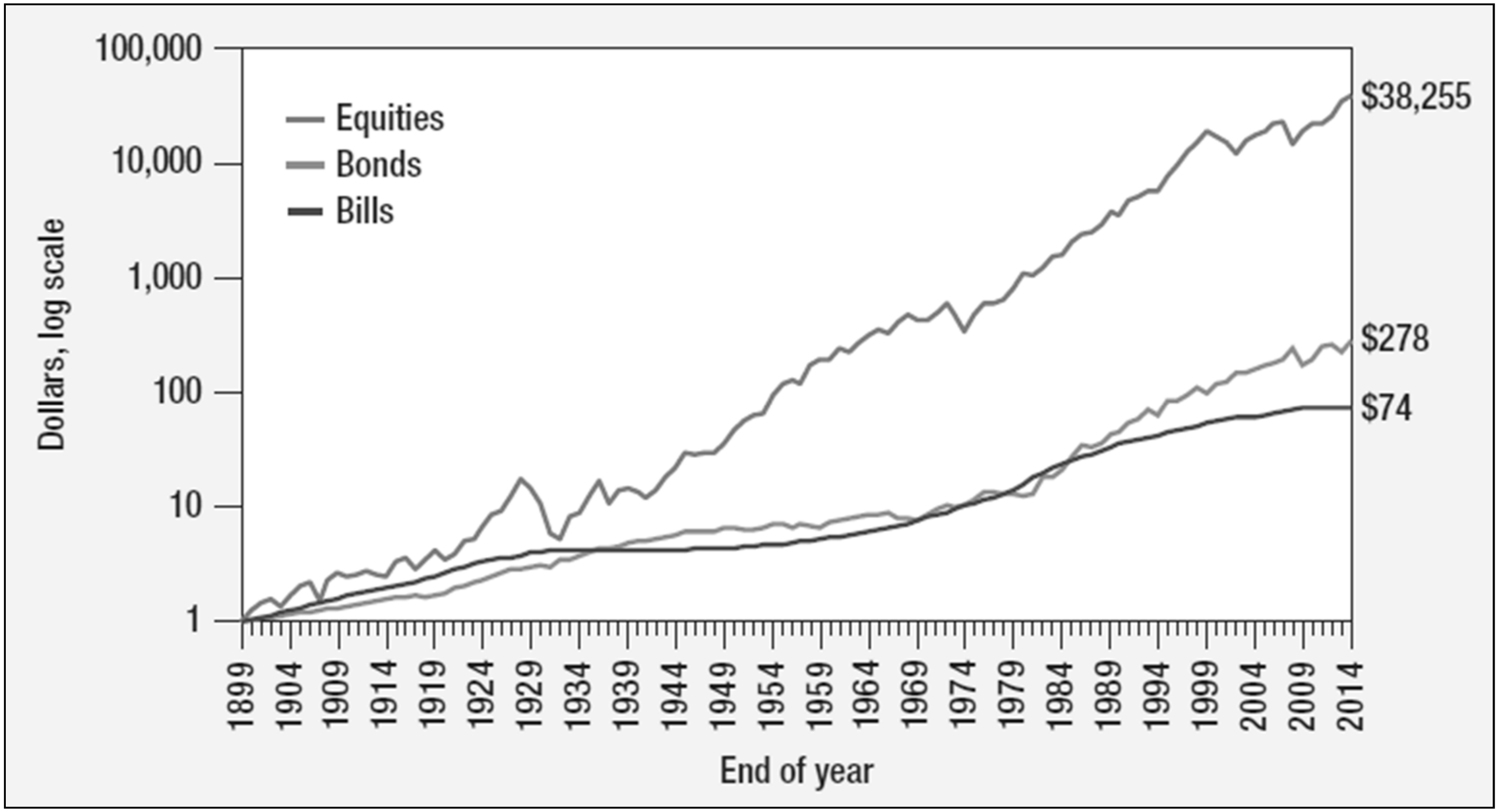
CHAPTER 7

INTRODUCTION TO RISK AND RETURN

Topics Covered

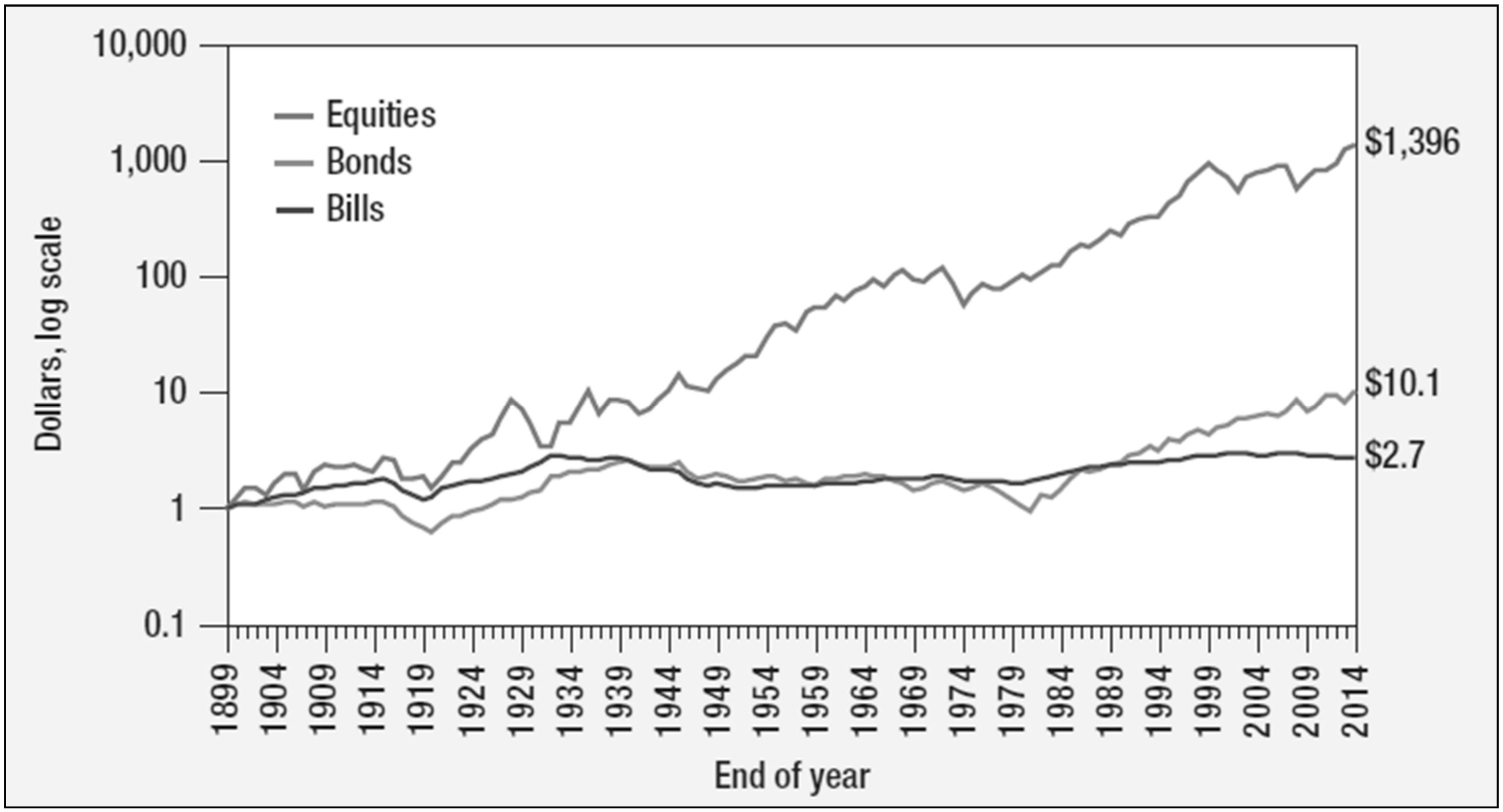
- Over a Century of Capital Market History in One Easy Lesson
- Measuring Portfolio Risk
- Calculating Portfolio Risk
- How Individual Securities Affect Portfolio Risk
- Diversification & Value Additivity

The Value of an Investment of $1 in 1899

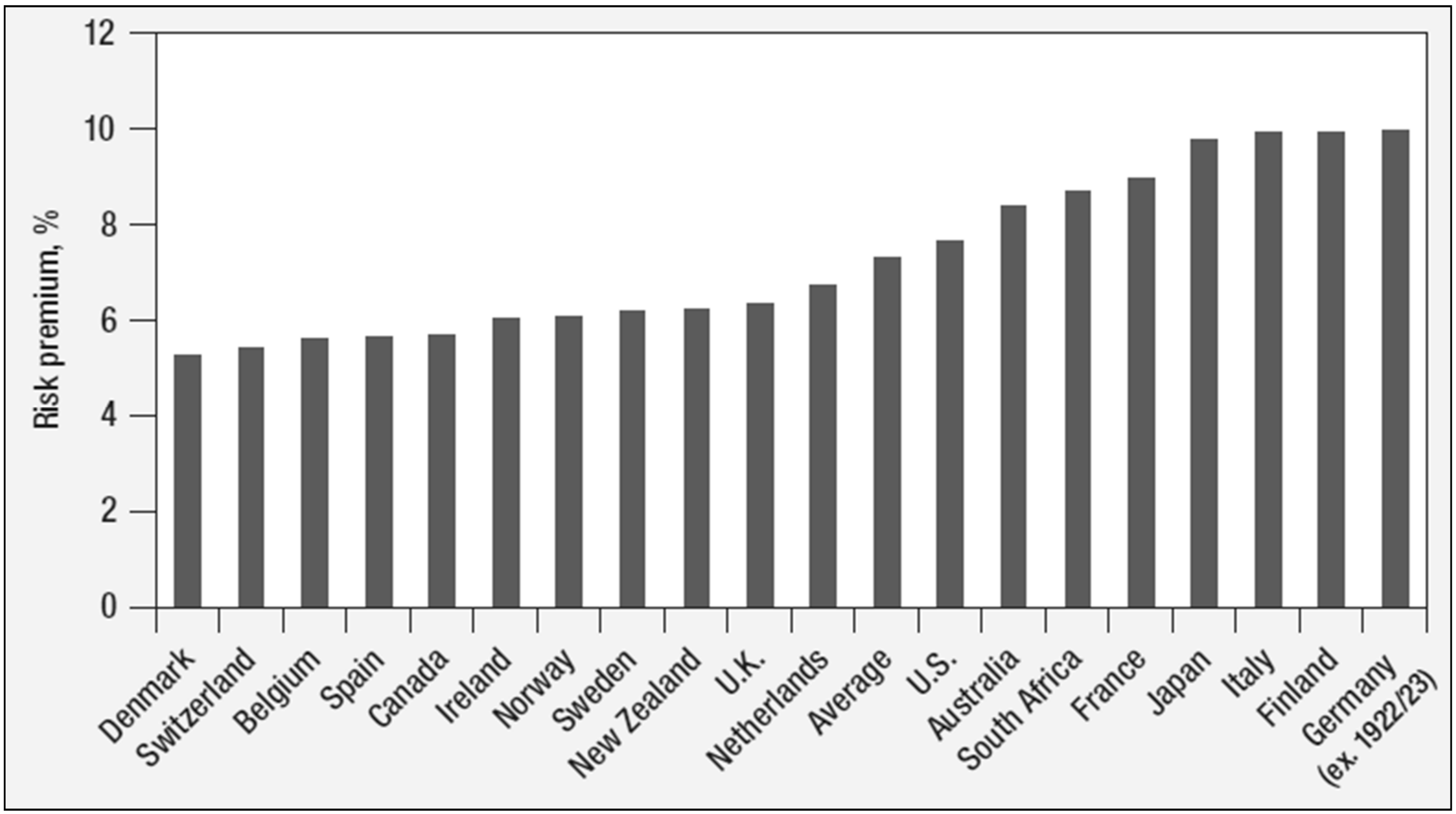


The Value of an Investment of $1 in 1899

Real Returns

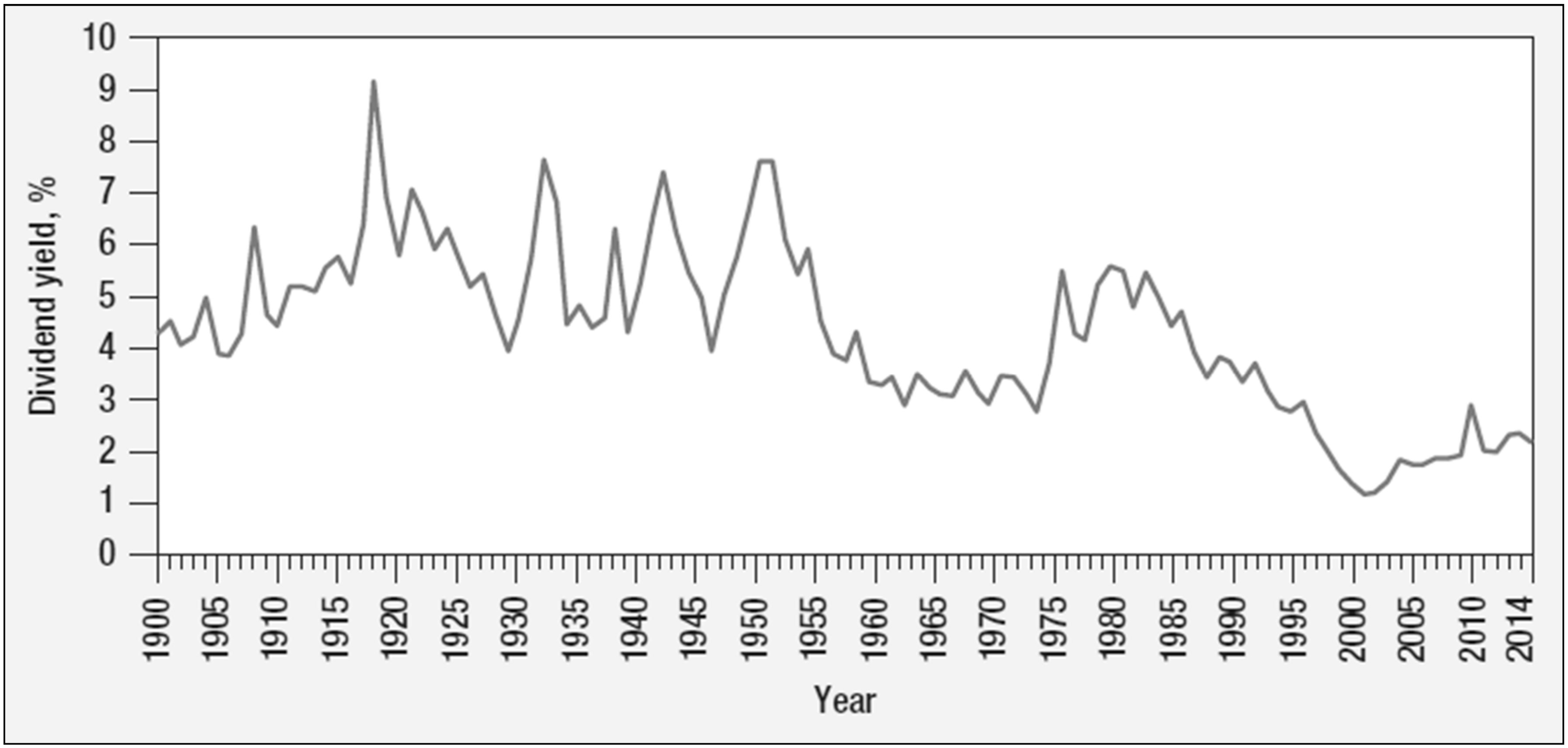


Average Market Risk Premiums (by country)



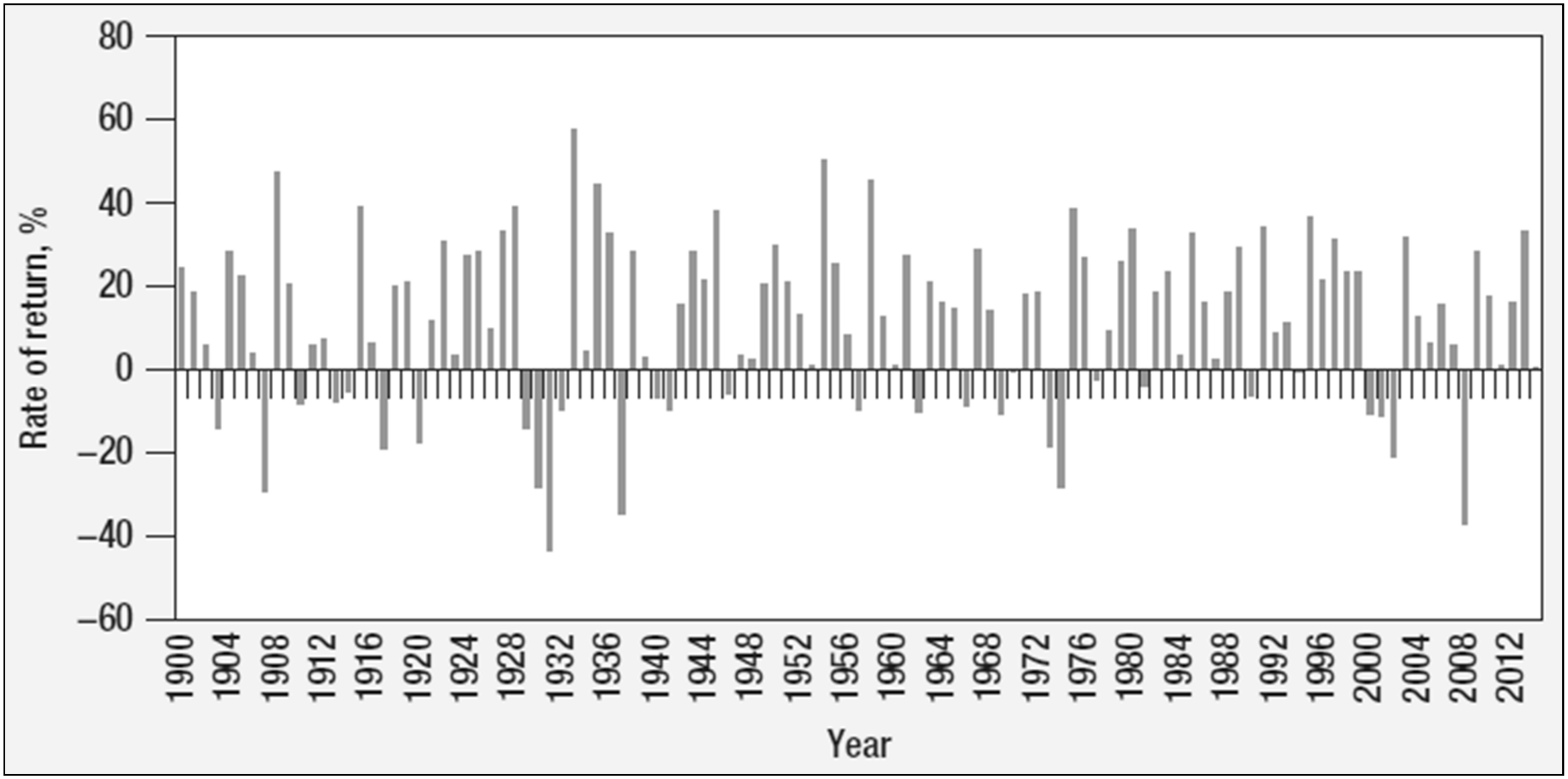
Dividend Yield

Dividend yields in the U.S. 1900–2014



Rates of Return 1900-2011

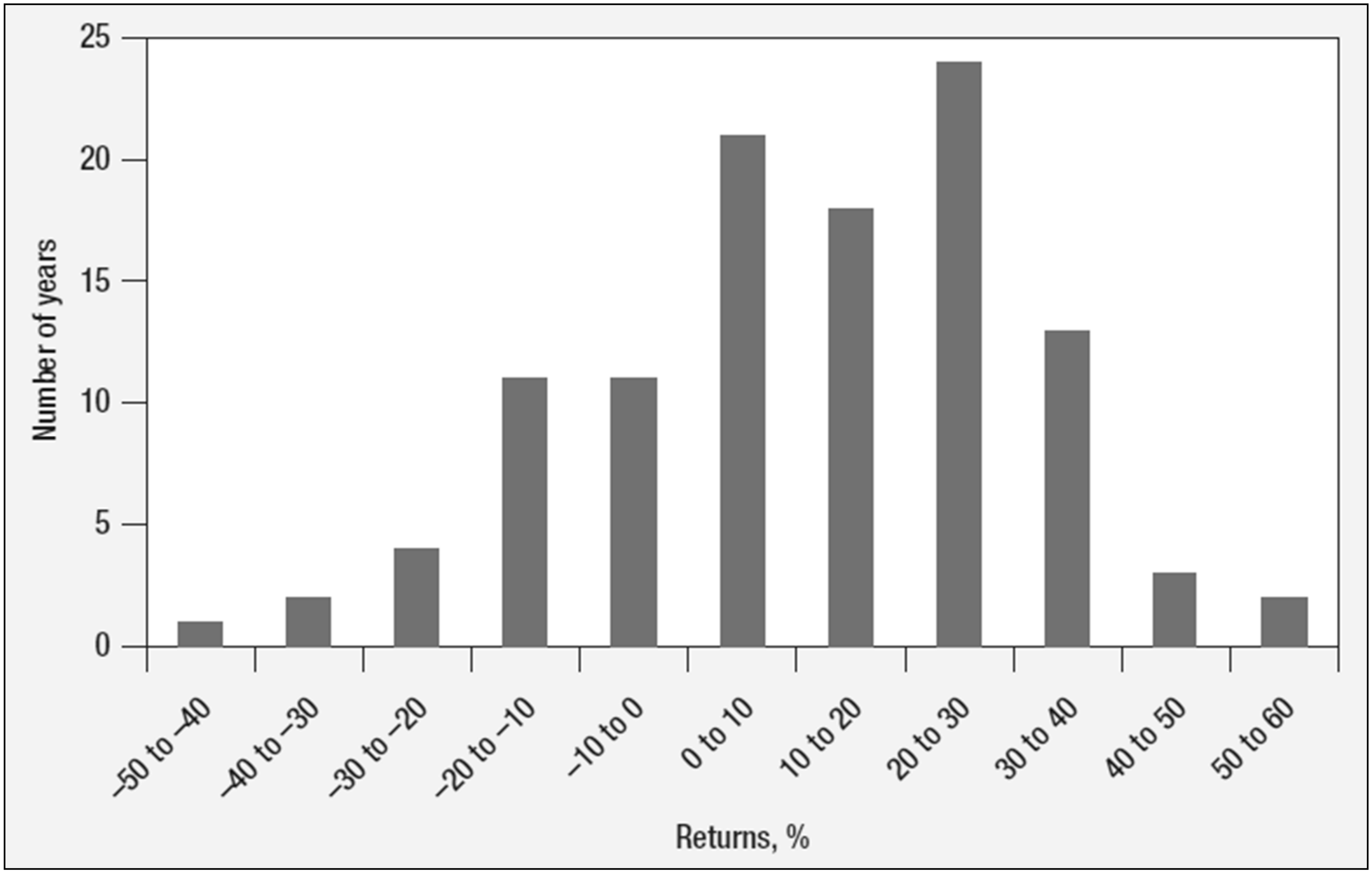
Stock Market Index Returns



Source: E. Dimson, P. R. Marsh, and M. Staunton, *Triumph of the Optimists: 101 Years of Investment Returns* (Princeton, NJ: Princeton University Press, 2002), with updates provided by the authors.

Measuring Risk

Histogram of Annual Stock Market Returns (1900-2014)



Measuring Risk

Variance

- Average value of squared deviations from mean
- A measure of volatility

Standard Deviation

- Average value of squared deviations from mean
- A measure of volatility

Measuring Risk

Coin Toss Game-calculating variance and standard deviation

(1) Percent Rate of Return ($\tilde{r}$)	(2) Deviation from Expected Return ($\tilde{r} - r$)	(3) Squared Deviation $(\tilde{r} - r)^2$	(4) Probability	(5) Probability × Squared Deviation
+40	+30	900	0.25	225
+10	0	0	0.5	0
–20	–30	900	0.25	225

Variance = expected value of $(\tilde{r} - r)^2 = 450$

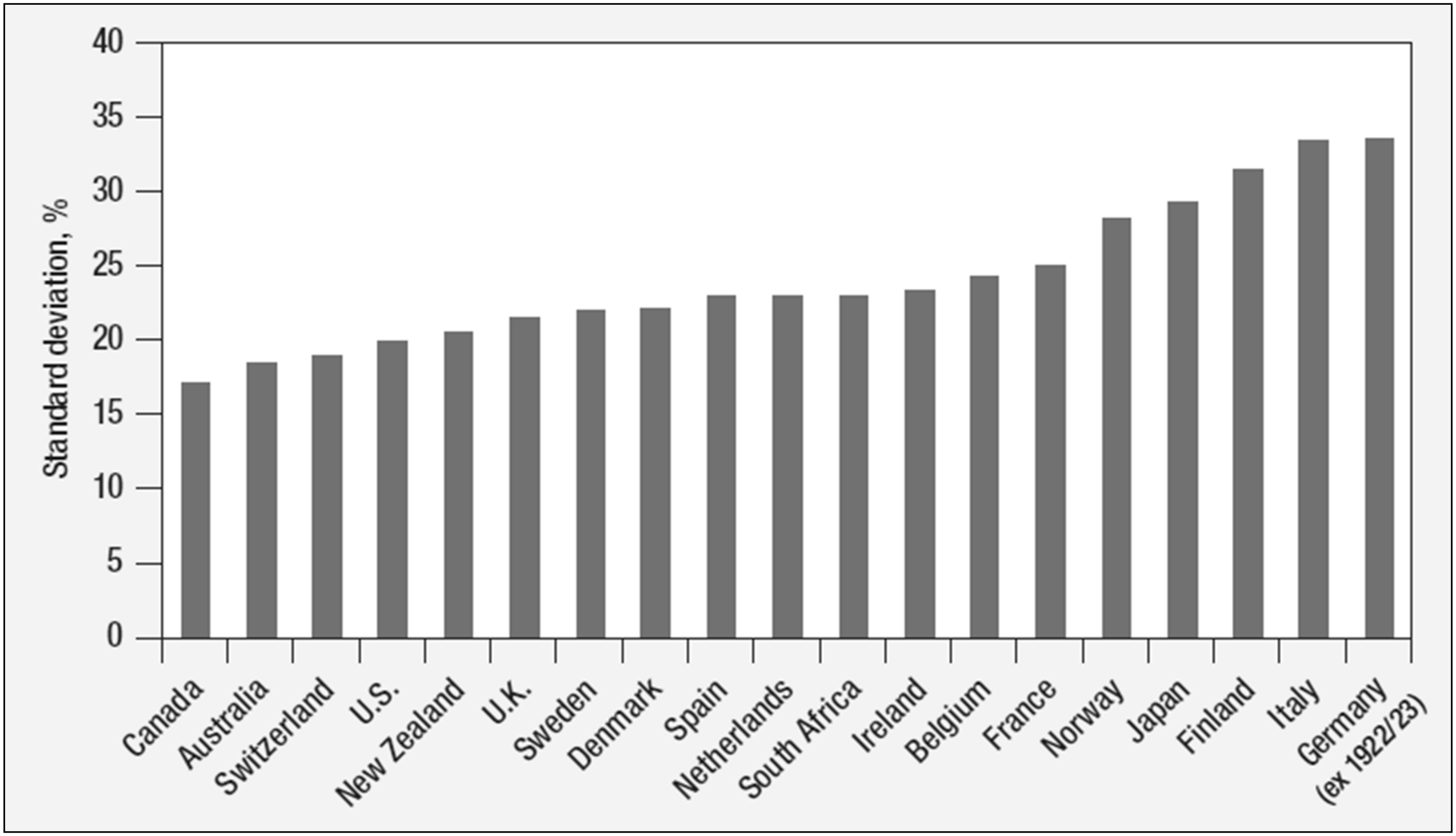
Standard deviation = $\sqrt{\text{variance}} = \sqrt{450} = 21$

Measuring Risk

$$\begin{aligned}\text{Portfolio rate of return} &= \begin{pmatrix}\text{fraction of portfolio}\\ \text{in first asset}\end{pmatrix} \times \begin{pmatrix}\text{rate of return}\\ \text{on first asset}\end{pmatrix}\\ &+ \begin{pmatrix}\text{fraction of portfolio}\\ \text{in second asset}\end{pmatrix} \times \begin{pmatrix}\text{rate of return}\\ \text{on second asset}\end{pmatrix}\end{aligned}$$

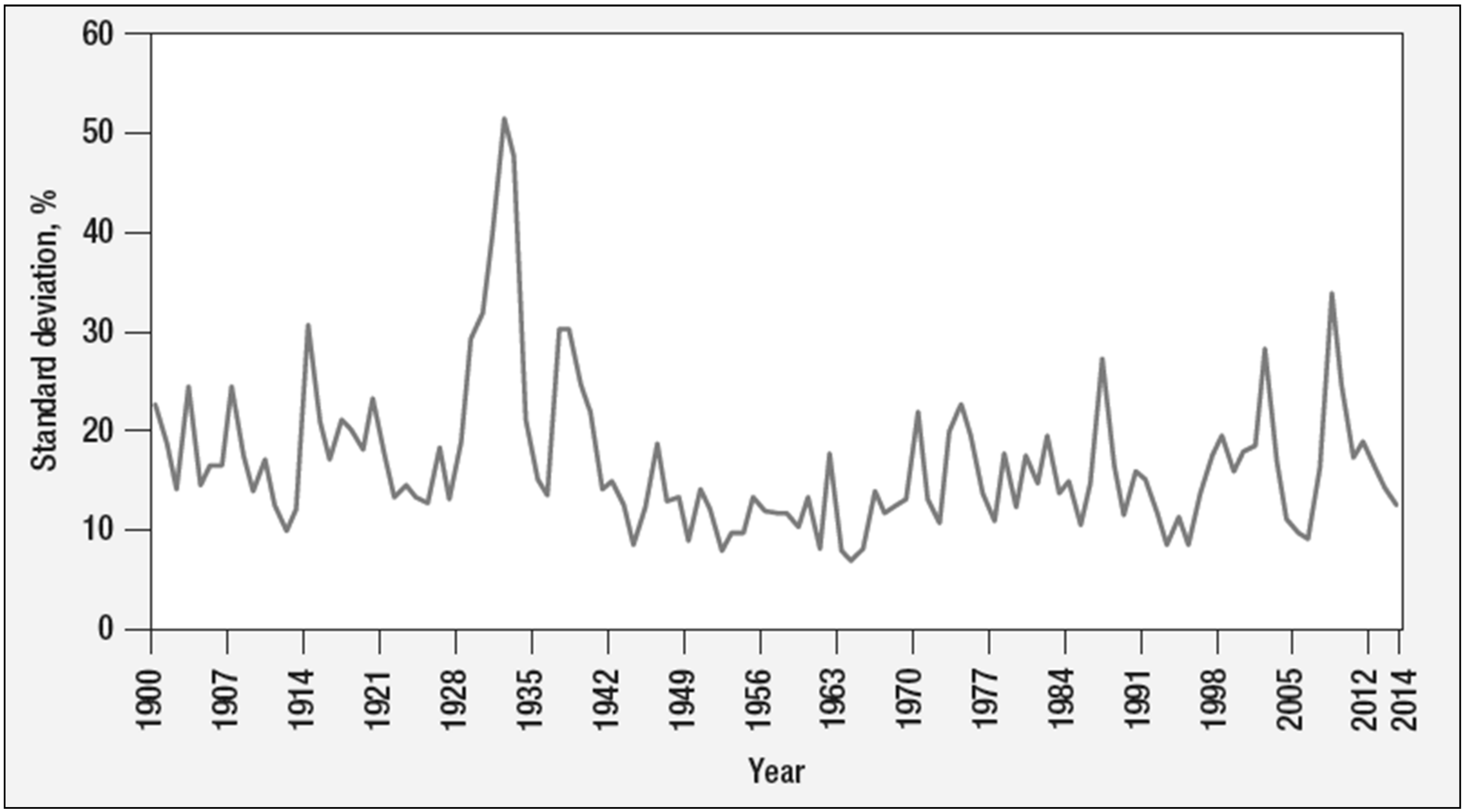
Equity Market Risk (by country)

Average Risk (1900-2014)



Dow Jones Risk

Annualised Standard Deviation of the DJIA over the preceding 52 weeks (1900 – 2014)



Measuring Risk

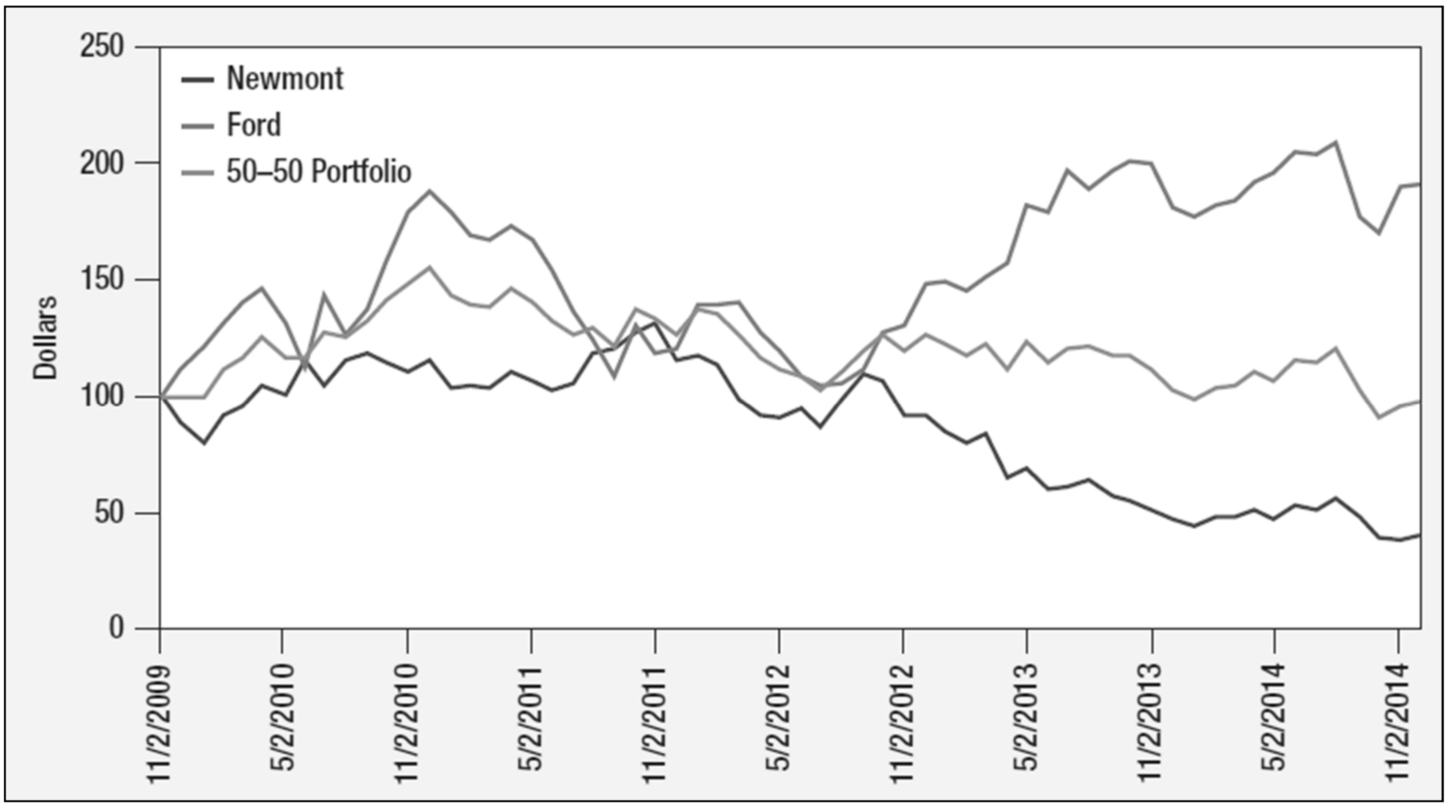
<u>Diversification</u> - Strategy designed to reduce risk by spreading the portfolio across many investments.

<u>Unique Risk</u> - Risk factors affecting only that firm. Also called “diversifiable risk.”

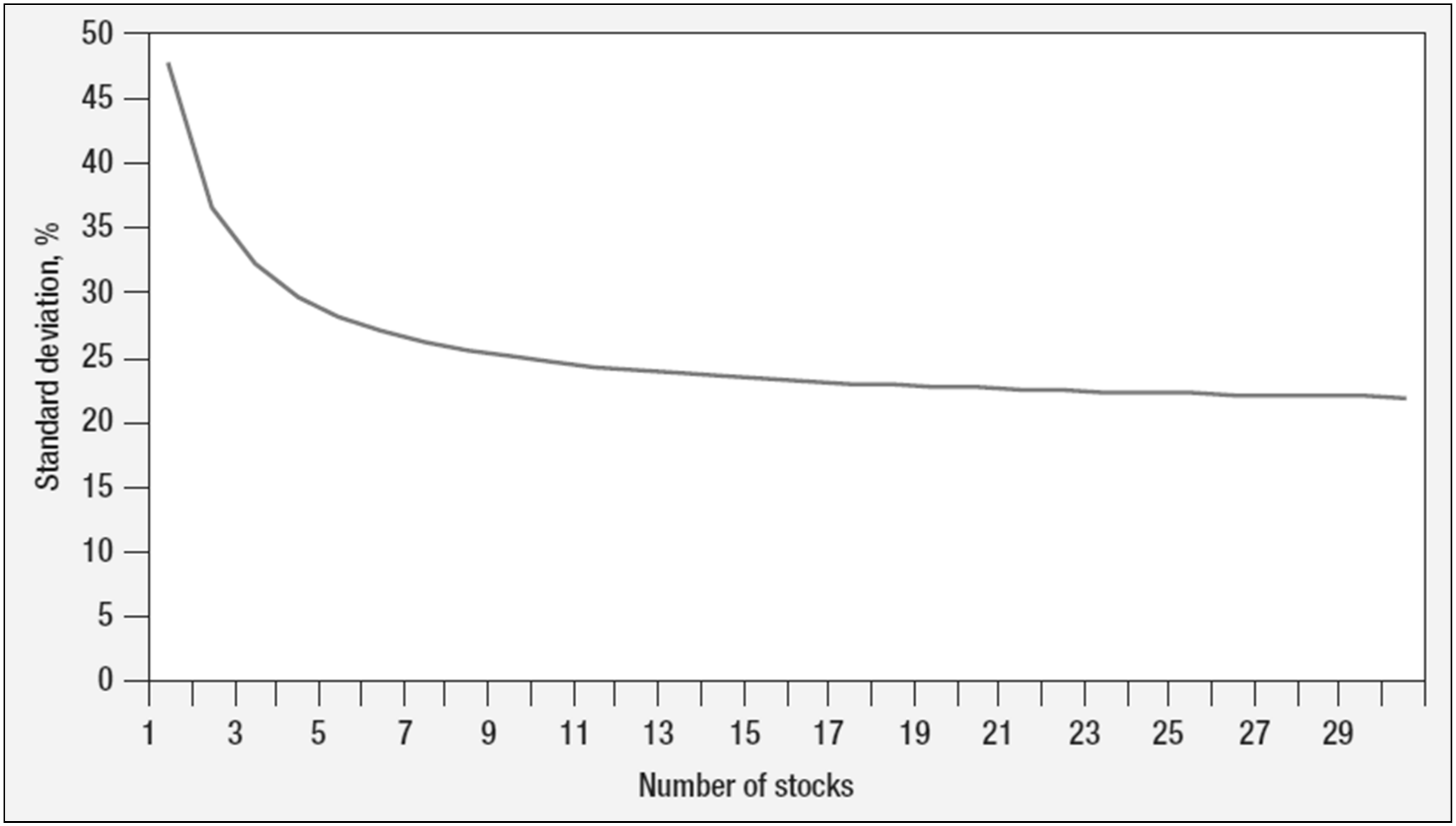
<u>Market Risk</u> - Economy-wide sources of risk that affect the overall stock market. Also called “systematic risk.”

Comparing Returns

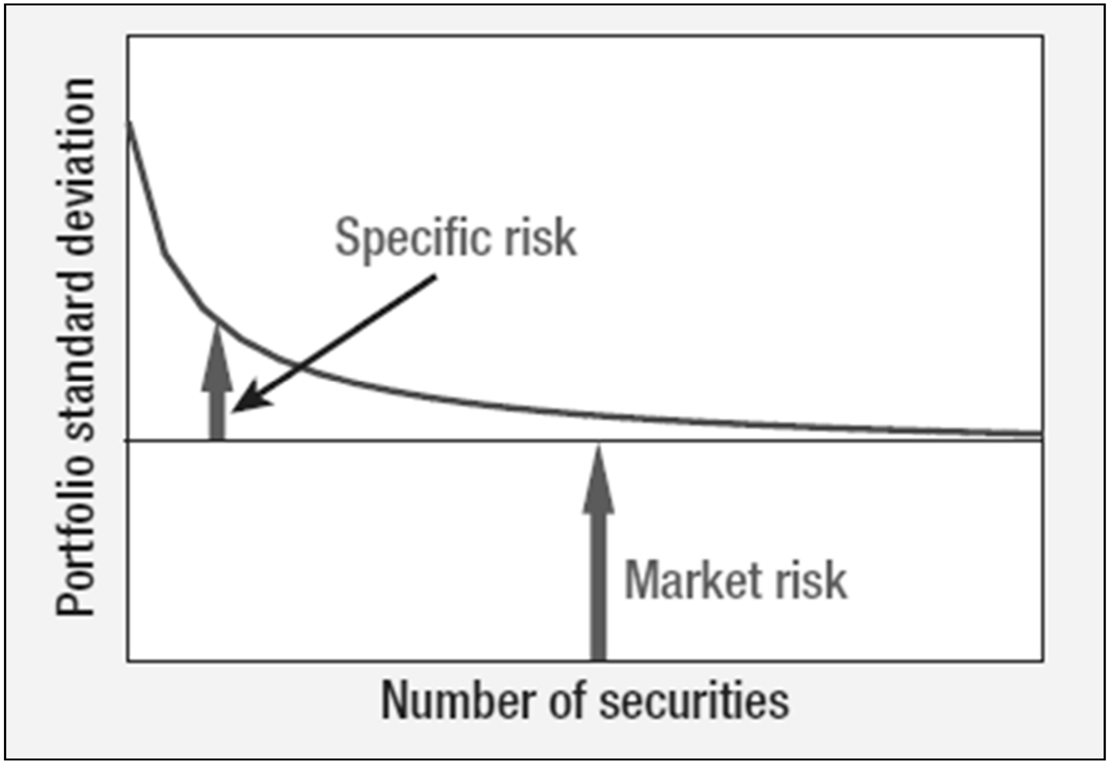
The value of a portfolio evenly divided between Newmont Mining and Ford was less volatile than either stock on its own. The assumed initial investment is $100.



Measuring Risk



Measuring Risk



Portfolio Risk

The variance of a two stock portfolio is the sum of these four boxes

	Stock 1	Stock 2
Stock 1	$x_1^2\sigma_1^2$	$x_1 x_2 \sigma_{12} = x_1 x_2 \rho_{12} \sigma_1 \sigma_2$
Stock 2	$x_1 x_2 \sigma_{12} = x_1 x_2 \rho_{12} \sigma_1 \sigma_2$	$x_2^2\sigma_2^2$

Portfolio Risk

Example

Suppose you invest 60% of your portfolio in JNJ and 40% in Ford. The expected dollar return on your JNJ is 8.0% and on Ford is 18.8%. The expected return on your portfolio is:

$$\text{Expected return} = (.60 \times 8.0) + (.40 \times 18.8) = 12.3\%$$

Portfolio Risk

Example

Suppose you invest 60% of your portfolio in JNJ and 40% in Ford. The expected dollar return on your JNJ is 8.0% and on Ford is 18.8%. The standard deviation of their annualised daily returns are 13.2% and 31.0%, respectively. Assume a correlation coefficient of 1.0 and calculate the portfolio variance.

	JNJ	Ford
JNJ	$x_1^2\sigma_1^2 = (.60)^2 \times (13.2)^2$	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .40 \times .60 \times 1 \times 13.2 \times 31.0$
Ford	$x_1 x_2 \rho_{12} \sigma_1 \sigma_2 = .40 \times .60 \times 1 \times 13.2 \times 31.0$	$x_2^2\sigma_2^2 = (.40)^2 \times (31.0)^2$

Portfolio Risk

Example

Suppose you invest 60% of your portfolio in JNJ and 40% in Ford. The expected dollar return on your JNJ is 8.0% and on Ford is 18.8%. The standard deviation of their annualized daily returns are 13.2% and 31.0%, respectively. Assume a correlation coefficient of 1.0 and calculate the portfolio variance.

$$\begin{aligned}\text{Portfolio variance} &= [(.60)^2 \times (13.2)^2] \\ &+ [(.40)^2 \times (31.0)^2] \\ &+ 2(.40 \times .60 \text{x} 1 \times 13.2 \times 31.0) = 412.90\end{aligned}$$

$$\text{Standard deviation} = \sqrt{412.90} = 20.3\,\%$$

Portfolio Risk

Example

Suppose you invest 60% of your portfolio in JNJ and 40% in Ford. The expected dollar return on your JNJ is 8.0% and on Ford is 18.8%. The standard deviation of their annualized daily returns are 13.2% and 31.0%, respectively. Assume a correlation coefficient of .019 and calculate the portfolio variance.

$$\begin{aligned}\text{Portfolio variance} = &[(.60)^2 \times (13.2)^2] \\ &+ [(.40)^2 \times (31.0)^2] \\ &+ 2(.40 \times .60 \times 0.19 \times 13.2 \times 31.0) = 253.80\end{aligned}$$

$$\text{Standard deviation} = \sqrt{253.80} = \boxed{15.90\ \%}$$

Portfolio Risk

Another Example

Suppose you invest 60% of your portfolio in JNJ and 40% in Ford. The expected dollar return on your JNJ is 8.0% and on Ford is 18.8%. The standard deviation of their annualized daily returns are 13.2% and 31.0%, respectively. Assume a correlation coefficient of -1.00 and calculate the portfolio variance.

$$\begin{aligned}\text{Portfolio variance} &= [(.60)^2 \times (13.2)^2] \\ &+ [(.40)^2 \times (31.0)^2] \\ &+ 2(.40 \times .60 \times (-1.00) \times 13.2 \times 31.0) = 20.1\end{aligned}$$

$$\text{Standard deviation} = \sqrt{20.10} = \boxed{4.50\,\%}$$

Portfolio Risk

$$\text{Expected portfolio return} = (x_1 r_1) + (x_2 r_2)$$

$$\text{Portfolio variance} = x_1^2\sigma_1^2 + x_2^2\sigma_2^2 + 2(x_1 x_2 \rho_{12}\sigma_1\sigma_2)$$

Portfolio Risk

Example Correlation Coefficient = .4

Stocks	σ	% of Portfolio	Avg Return
ABC Corp	28	60%	15%
Big Corp	42	40%	21%

Standard deviation = weighted avg = 33.6

Standard deviation = Portfolio = 28.1

Real standard deviation:

$= (28^{2)}(.6^2) + (42^2)(.4^2) + 2(.4)(.6)(28)(42)(.4)$

= 28.1 CORRECT

Return : r = (15%)(.60) + (21%)(.4) = 17.4%

Portfolio Risk

Correlation Coefficient = .4

Stocks	σ	% of Portfolio	Avg Return
ABC Corp	28	60%	15%
Big Corp	42	40%	21%

Standard deviation = weighted avg = 33.6

Standard deviation = portfolio = 28.1

Return = weighted avg = portfolio = 17.4%

Let's add New Corp. stock to the portfolio

Portfolio Risk

Example   Correlation Coefficient = .3

Stocks	σ	% of Portfolio	Avg Return
Portfolio	28.1	50%	17.4%
New Corp	30	50%	19%

NEW standard deviation = weighted avg = 31.80

NEW standard deviation = portfolio = 23.43

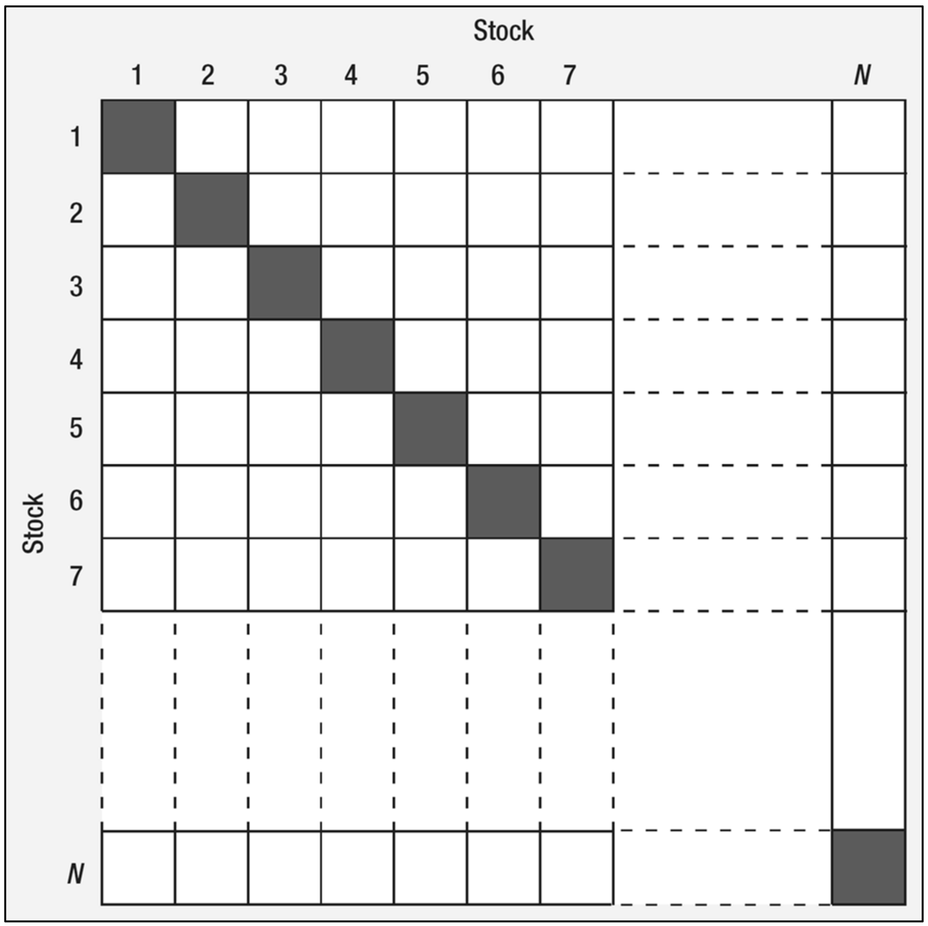
NEW return = weighted avg = portfolio = 18.20%

NOTE: Higher return & Lower risk

How did we do that? DIVERSIFICATION

Portfolio Risk

The shaded boxes contain variance terms; the remainder contain covariance terms.



To calculate portfolio variance add up the boxes

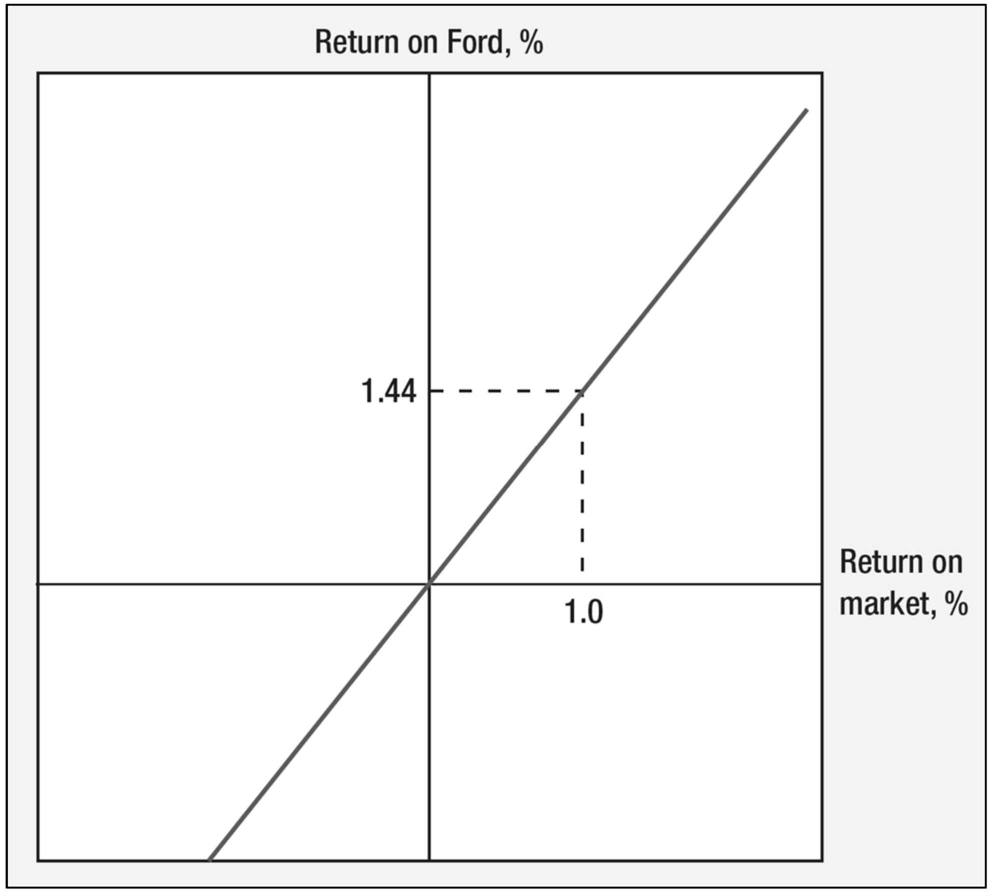
Portfolio Risk, Beta

Market Portfolio - Portfolio of all assets in the economy. In practice a broad stock market index, such as the S&P Composite, is used to represent the market.

Beta - Sensitivity of a stock's return to the return on the market portfolio.

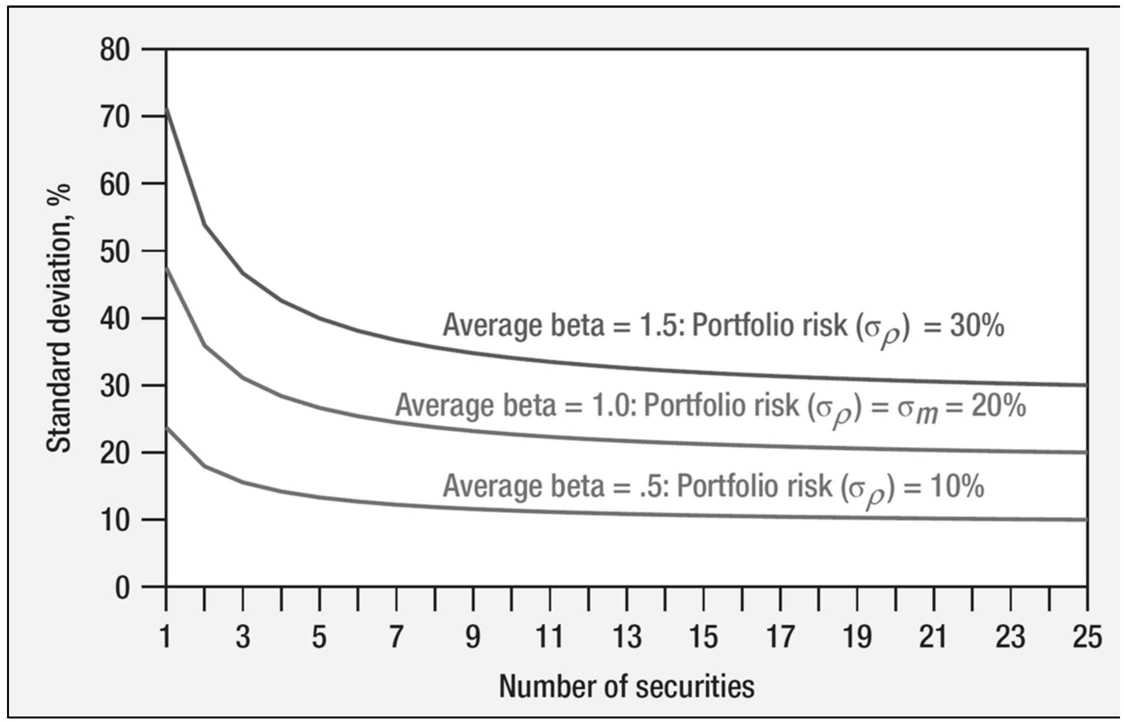
Portfolio Risk, Beta

The return on Ford stock changes on average by 1.44% for each additional 1% change in the market return. Beta is therefore 1.44.



Portfolio Risk, Beta

The green line shows that a well diversified portfolio of randomly selected stocks ends up with β = 1 and a standard deviation equal to the market's—in this case 20%. The upper red line shows that a well diversified portfolio with β = 1.5 has a standard deviation of about 30%—1.5 times that of the market. The lower blue line shows that a well-diversified portfolio with β = .5 has a standard deviation of about 10%—half that of the market.



Portfolio Risk, Beta

$$B_i = \frac{\sigma_{im}}{\sigma_m^2}$$

Covariance with the market

Variance of the market

Portfolio Risk, Beta

Calculating the variance of the market returns and the covariance between the returns on the market and those of Anchovy Queen. Beta is the ratio of the variance to the covariance (i.e., $\beta = \sigma_{im} / \sigma^2_m$)

1	(1)	(2)	(3)	(4)	(5)	(6)	(7)
2							Product of
3				Deviation	Deviation	Squared	deviations
4				from	from average	deviation	from average
5		Market	Anchovy Q	average	Anchovy Q	from average	returns
6	Month	return	return	market return	return	market return	(cols 4 × 5)
7	1	– 8%	– 11%	– 10	– 13	100	130
8	2	4	8	2	6	4	12
9	3	12	19	10	17	100	170
10	4	– 6	– 13	– 8	– 15	64	120
11	5	2	3	0	1	0	0
12	6	8	6	6	4	36	24
13	Average	2	2		Total	304	456
14				Variance $= \sigma^2_m = 304/6 = 50.67$			
15				Covariance $= \sigma_{im} = 456/6 = 76$			
16				Beta $(\beta) = \sigma_{im}/\sigma^2_m = 76/50.67 = 1.5$			