

## MEASURING PORTFOLIO RISK: CO-MOVEMENT BETWEEN SECURITIES

### PORTFOLIO RISK: CO-MOVEMENT BETWEEN SECURITIES

- ▶ The variance of a portfolio is not a weighted average of the individual variances.
- ▶ The variance of a portfolio's return is affected by how the securities 'co-move'.
- ▶ Therefore, we need to define **covariance** and **correlation** measures that allow us to evaluate how securities move or do not move together.

## COVARIANCE

- Covariance is a measure of the pair-wise co-movement between two securities.

## MEASURING COVARIANCE BETWEEN TOYOTA AND PFIZER

State of the economy	Prob.	Toyota	Pfizer
Expansion	0.10	6.0%	2.5%
Normal	0.40	7.5	-0.5
Recession	0.30	2.0	1.0
Depression	0.20	-3.0	13.0
<b>Expected return E(R)</b>		<b>3.60%</b>	<b>2.95%</b>
<b>Standard deviation <math>\sigma</math></b>		<b>4.02%</b>	<b>5.11%</b>

## **CORRELATION**

- One drawback of the covariance measure is that its magnitude does not tell us much about the strength of the co-movement. Correlation is a standardized measure of co-movement.

## **MEASURING CORRELATION BETWEEN TOYOTA AND PFIZER**

## **PORTFOLIO RISK**

## **RISK OF A TWO-ASSET PORTFOLIO**

- How can we incorporate this measure of co-movement into the calculation of portfolio variance?

## PORTFOLIO RISK: $\frac{1}{2}$ TOYOTA + $\frac{1}{2}$ PFIZER

State of the economy	Prob.	Toyota	Pfizer	$\frac{1}{2}$ Toyota + $\frac{1}{2}$ Pfizer
Expected return E(R)		3.60%	2.95%	3.275%
Standard deviation $\sigma$		4.02%	5.11%	1.29%

## PORTFOLIO RISK: $\frac{1}{2}$ TOYOTA + $\frac{1}{2}$ WALMART

State of the economy	Prob.	Toyota	Walmart	$\frac{1}{2}$ Toyota + $\frac{1}{2}$ Walmart
Expected return E(R)		3.60%	3.65%	3.625%
Standard deviation $\sigma$		4.02%	2.41%	3.16%

## RISK OF A 2-ASSET PORTFOLIO

<u>Portfolio</u>	<u>Portfolio Standard Deviation</u>	<u>Avg. Standard Deviation of the 2 stocks</u>	<u>Diversification?</u>	<u>Why?</u>
50% Toyota 50% Walmart	3.16	3.21	Very little	Nearly Perfect Positive Correlation
50% Toyota 50% Pfizer	1.29	4.56	Lots	Nearly Perfect Negative Correlation

## EFFECT OF CORRELATION ON TWO- ASSET PORTFOLIO RISK

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<u>Correlation coefficient</u>	<u>Effect of diversification on risk</u>
+1.0	No risk reduction is possible
+ 0.5	Moderate risk reduction is possible
0	Considerable risk reduction is possible
- 0.5	Most risk can be eliminated
- 1.0	All risk can be eliminated

## SUMMARY

- ▶ You learned how to compute the portfolio variance for a two-asset portfolio.
- ▶ Portfolio risk is not simply a weighted average of the individual assets.
- ▶ How assets co-move together is ultimately what affects portfolio risk.



# **DIVERSIFICATION: SYSTEMATIC VS. IDIOSYNCRATIC RISK**

## **WHAT WILL YOU LEARN?**

- ▶ Why does diversification reduce risk?
- ▶ What is systematic risk?
- ▶ What is idiosyncratic risk?

## EFFECT OF CORRELATION ON TWO-ASSET PORTFOLIO RISK

### Correlation coefficient

+1.0

+ 0.5

0

- 0.5

- 1.0

### Effect of diversification on risk

No risk reduction is possible

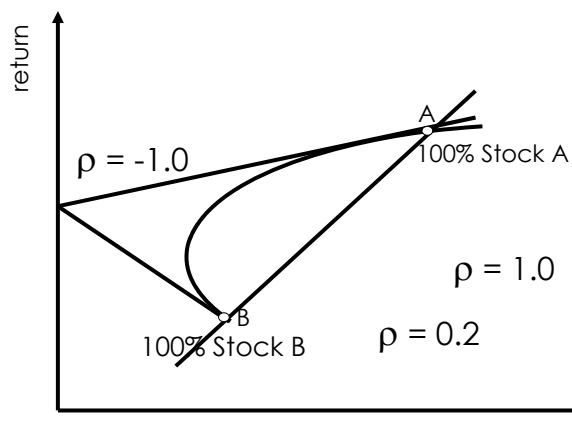
Moderate risk reduction is possible

Considerable risk reduction is possible

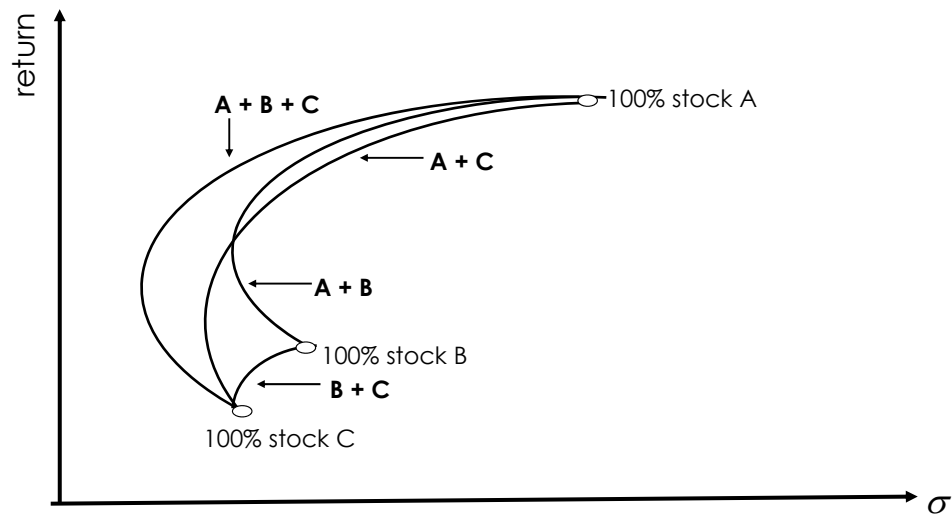
Most risk can be eliminated

All risk can be eliminated

## EFFECT OF CORRELATION ON A TWO-SECURITY PORTFOLIO RISK



## WHAT IF YOU HAD MORE THAN TWO STOCKS?

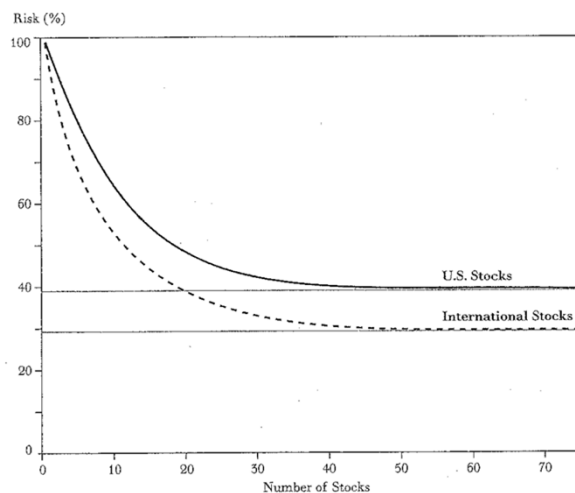


## PORTFOLIO VARIANCE WITH N ASSETS

## WHY DOES DIVERSIFICATION REDUCE RISK?

- ▶ There are two sources of risk:
  - ▶ Market-wide risk or systematic risk
  - ▶ Idiosyncratic (or firm-specific or unique or non-systematic) risk
- ▶ When securities are combined into a portfolio, the unique risk tends to cancel out or gets diversified away.
- ▶ In a well-diversified portfolio, what remains is the risk that can not be diversified away. This is the systematic or market risk.

## LIMITS TO DIVERSIFICATION



Malkiel, B. A Random Walk Down Wall Street, (2012)

## SO, WHY DO PEOPLE DIVERSIFY?



### SUMMARY

- ▶ When assets are imperfectly correlated, combining them into a portfolio reduces the total variance – the risk – of the portfolio return.
- ▶ Diversification eliminates unsystematic risk.
- ▶ A well-diversified portfolio contains only systematic risk that cannot be diversified away.