Defining and Measuring Risk

- Risk is the chance that an unexpected outcome will occur.
- A probability distribution is a listing of all possible outcomes with a probability assigned to each.

Probability Distributions

- It either will rain, or it will not rain; there are only two possible outcomes.

Outcome	Probability		
Rain	0.40	=	40%
No Rain	0.60	=	60%
	1.00		100%

Probability Distributions

- Martin Products and U. S. Electric

State of the Economy	Probability of This State Occurring	Rate of Return on Stock if the Economic State Occurs	
		Martin Prod.	U.S. Electric
Boom	0.2	110%	20%
Normal	0.5	22	16
Recession	0.3	–60	10
	1.0		

Expected Rate of Return

- Rate of return expected to be realized from an investment during its life.
- Mean value of the probability distribution of possible returns.
- Weighted average of the outcomes, where the weights are the probabilities.

Expected Rate of Return

$$\text{Expected rate of return} = Pr_1\ r_1 + Pr_2\ r_2 + \cdots + Pr_n\ r_n$$

$$\hat{r} = \sum_{i=1}^{n} Pr_i\ r_i$$

Total Risk (Stand-Alone Risk): The Standard Deviation (σ)

$$\text{Standard deviation} = \sigma = \sqrt{(r_1 - \hat{r})^2 Pr_1 + (r_2 - \hat{r})^2 Pr_2 + \cdots + (r_n - \hat{r})^2 Pr_n}$$

$$= \sqrt{\sum_{i=1}^{n} (r_i - \hat{r})^2 Pr_i}$$

Standard Deviation (σ): Martin Products

r_i		$\hat{r}$		$r_i - \hat{r}$	$(r_i - \hat{r})^2$		$(r_i - \hat{r})^2 Pr_i$		
(1)	–	(2)	=	(3)	(4)	(5)	(4) x (5)	=	(6)
110%	–	15%	=	95	9,025	0.2	9,025 x 0.2	=	1,805.0
22	–	15	=	7	49	0.5	49 x 0.5	=	24.5
–60	–	15	=	–75	5,625	0.3	5,625 x 0.3	=	1,687.5
							Variance = σ^2	=	3,517.0

Standard deviation = σ = $\sqrt{\sigma^2} = \sqrt{3{,}517} = 59.3\%$

Estimated Standard Deviation, s

$$\text{Estimated } \sigma = s = \sqrt{\frac{\sum_{t=1}^{n} (\ddot{r}_t - \bar{r})^2}{n-1}}$$

$$\bar{r} = \frac{\ddot{r}_1 + \ddot{r}_2 + \cdots + \ddot{r}_n}{n} = \frac{\sum_{t=1}^{n} \ddot{r}_t}{n}$$

Measuring Risk: Coefficient of Variation

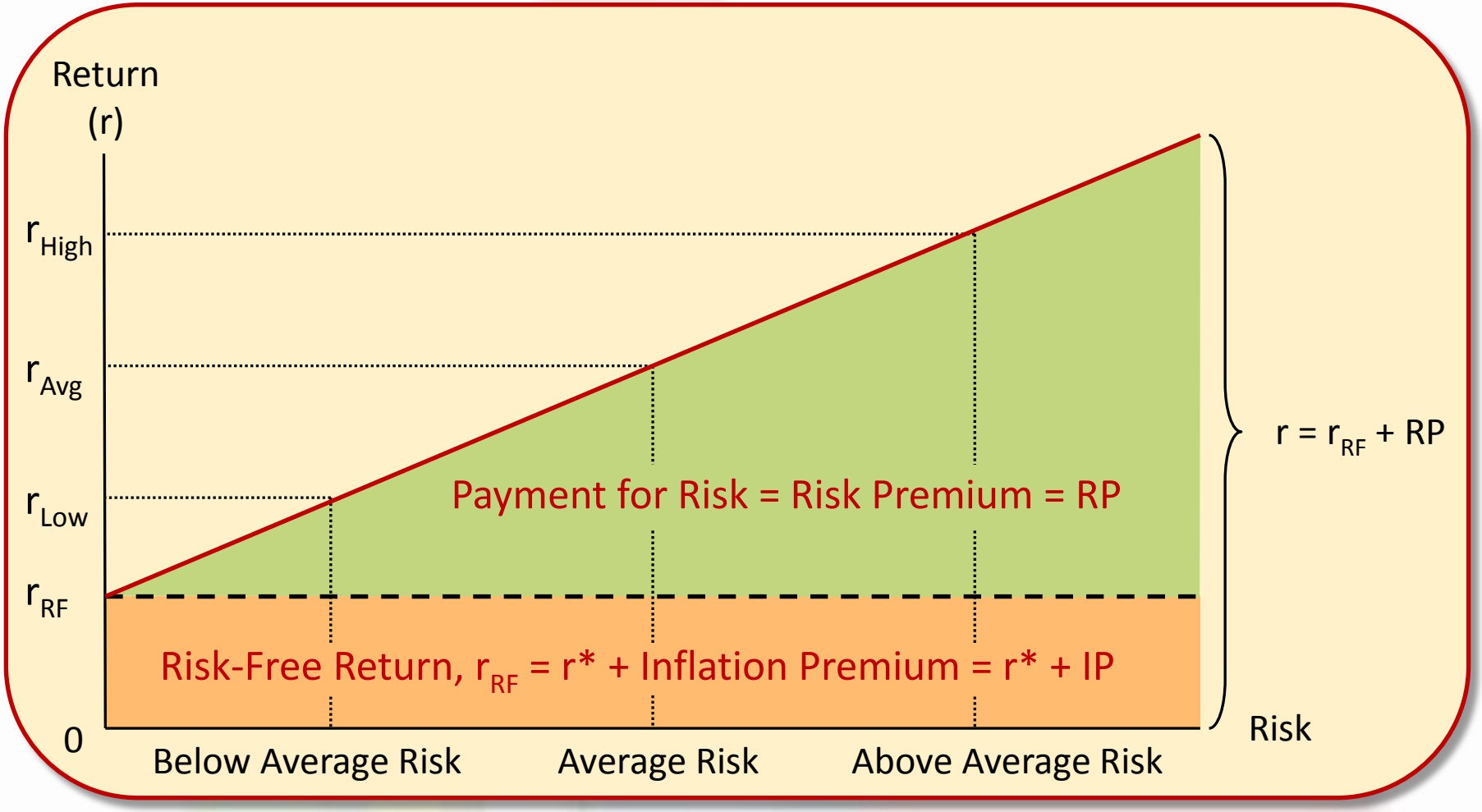
- Calculated as the standard deviation divided by the expected return.
- Useful where investments differ in risk *and* expected returns.

$$\text{Coefficient of variation} = \text{CV} = \frac{\text{Risk}}{\text{Return}} = \frac{\sigma}{\hat{r}}$$

Risk Aversion and Required Returns

- Risk-averse investors require higher rates of return to invest in higher-risk securities.
- Risk Premium (RP):
  - The portion of the expected return that can be attributed to an investment's riskiness.
  - The difference between the expected rate of return on a given risky asset and that on a less risky asset.

Risk/Return Relationship



Portfolio Returns

- Expected return on a portfolio, $\hat{r}_p$

$$\text{Portfolio return} = \hat{r}_P = w_1\hat{r}_1 + w_2\hat{r}_2 + \cdots + w_N\hat{r}_N = \sum_{j=1}^{N} w_j\hat{r}_j$$

The weighted average expected return on the stocks held in the portfolio.

Portfolio Returns

- Realized rate of return, $\ddot{r}$
  - The return that is actually earned.
  - Actual return usually differs from expected return.

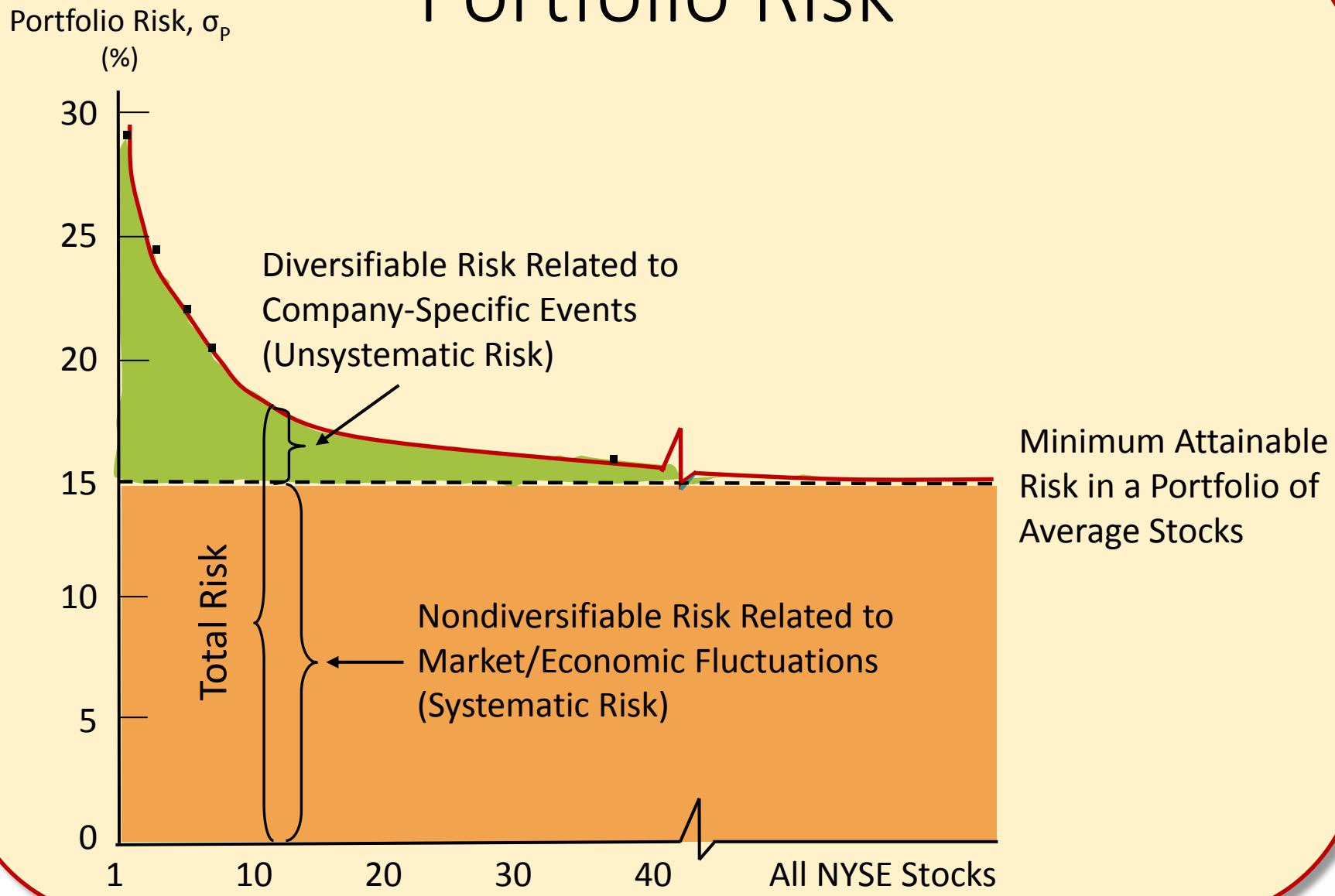
Portfolio Risk

- Correlation Coefficient, ρ
  - Measures the degree of relationship between two variables.
  - Positively correlated stocks ($\rho > 0$) have rates of return that move in the same direction.
  - Negatively correlated stocks ($\rho < 0$) have rates of return that move in opposite directions.

Portfolio Risk

- Risk Reduction
  - Combining stocks that are not perfectly correlated will reduce the portfolio risk through diversification.
  - The riskiness of a portfolio is reduced as the number of stocks in the portfolio increases.
  - The smaller the positive correlation, the lower the risk.
  - The greater the negative correlation, the lower the risk.

Portfolio Risk



Firm-Specific Risk versus Market Risk

- Firm-Specific Risk:
  - That part of a security's risk associated with random outcomes generated by events, or behaviors, specific to the firm.
  - Firm-specific risk can be eliminated through proper diversification.
  - Also called diversifiable risk or unsystematic risk.

Firm-Specific Risk versus Market Risk

- Market Risk:
  - That part of a security's risk that cannot be eliminated through diversification because it is associated with economic, or market factors that systematically affect all firms.
  - Also called nondiversifiable risk or systematic risk.

Firm-Specific Risk versus Market Risk

- **Relevant risk** = market risk:
  - The risk associated with a security that cannot be diversified away
  - This risk reflects a security's contribution to the total risk of a portfolio.
- **Irrelevant risk** = firm-specific risk:
  - The risk associated with a security that can be diversified away.

The Concept of Beta

- Beta Coefficient, β:
  - A measure of the extent to which the returns on a given stock move with the stock market, which represents an "average" stock.
  - The entire market is extremely well diversified (theoretically perfectly diversified), because it includes all investments.

The Concept of Beta (cont.)

- $\beta = 0.5$: stock is only half as volatile, or risky, as the average stock.
- $\beta = 1.0$: stock has the same risk as the average stock (same as the market).
- $\beta = 2.0$: stock is twice as risky as the average stock.

Portfolio Beta Coefficients

- The beta of any set of securities is the weighted average of the individual securities' betas

$$\text{Portfolio beta} = \beta_p = w_1\beta_1 + w_2\beta_2 + \cdots + w_N\beta_N$$

$$= \sum_{j=1}^{N} w_j\beta_j$$

Risk Premium for a Stock

$$\text{Risk premium for Stock j} = RP_j = RP_M \times \beta_j$$
$$= (r_M - r_{RF})\beta_j$$

RP_M = Market (average stock) risk premium

r_M = Market (average stock) return

r_{RF} = Risk-free rate of return

The Required Rate of Return for a Stock, r_j

Required return = Risk-free return + Premium for risk

$$r_j = r_{RF} + RP_j$$

$$= r_{RF} + (RP_M)\beta_j$$

$$= r_{RF} + (r_M - r_{RF})\,\beta_j$$

Capital Asset Pricing Model (CAPM)

- A model used to determine the required return on an asset, which is based on the proposition that any asset's required rate of return should equal the risk-free return plus a risk premium that reflects the asset's *nondiversifiable* risk.

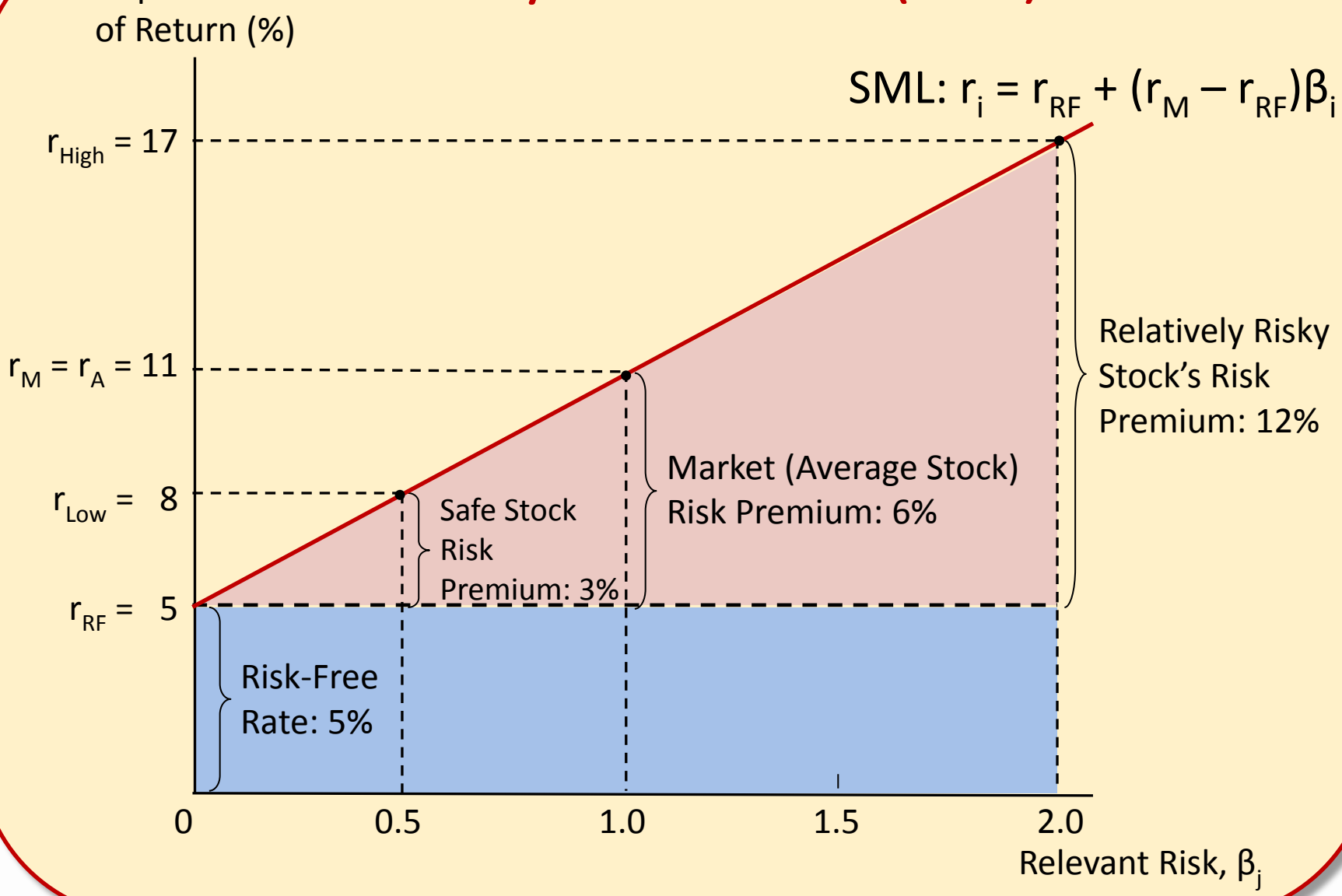
Required return = Risk-free return + Risk premium for systematic risk

$$r_j = r_{RF} + (r_M - r_{RF})\,\beta_j$$

Security Market Line (SML):

- A graph of the CAPM
- The line that shows the relationship between risk as measured by beta and the required rate of return for individual securities.

Security Market Line (SML)



The Impact of Inflation

- r_{RF} is the price of money to a riskless borrower.
- The nominal rate consists of:
  - a real (inflation-free) rate of return, and
  - an inflation premium (IP)
- An increase in expected inflation would increase the risk-free rate.
- The SML would experience a parallel, upward shift.

Changes in Risk Aversion

- The slope of the SML reflects the extent to which investors are averse to risk.
- An increase in risk aversion increases the risk premium, which increases the slope of the SML.

Changes in a Stock's Beta Coefficient

- The Beta risk of a stock is affected by:
  - composition of its assets
  - use of debt financing
  - increased competition
  - expiration of patents
- Any change in the required return (from change in beta or in expected inflation) affects the stock price.

Stock Market Equilibrium

- The condition under which the expected return on a security, r, is just equal to its required return, $\hat{r}$
- Actual market price equals its intrinsic value as estimated by the average investor, which leads to price stability; otherwise, buying or selling in the market makes the appropriate adjustment.

Changes in Equilibrium Stock Prices

- Stock prices are not constant due to changes in:
  - Risk-free rate, $r_{RF,}$
  - Market risk premium, $r_M - r_{RF,}$
  - Stock's beta coefficient, $\beta_{s,}$
  - Stock's expected growth rate, g, and
  - Changes in expected dividends, $\hat{D}_t$.

Physical Assets Versus Securities

- Riskiness of real assets is only relevant in terms of its effect on the stock's risk.

Word of Caution

- CAPM
  - Based on expected conditions
  - Only have historical data
  - As conditions change, future volatility might differ from past volatility
  - Estimates are subject to error

Different Types of Risk

- Systemic Risks
  - Interest rates
  - Inflation
  - Maturity
  - Liquidity
  - Exchange rate
  - Political

Different Types of Risk (cont.)

- Unsystemic Risks
  - Business
  - Financial
  - Default
- Combined Risks
  - Total
  - Corporate

What is Capital Budgeting?

- The process of planning and evaluating expenditures on assets whose cash flows are expected to extend beyond one year.
  - Analysis of potential additions to fixed assets.
  - Long-term decisions generally involve large expenditures.
  - Very important to firm's future.

Generating Ideas for Capital Projects

- Both a firm's growth and its ability to remain competitive depend on a constant flow of ideas for new products, ways to make existing products better, and ways to produce output at a lower cost.
- Procedures must be established for evaluating the worth of such projects.

Project Classifications

- Replacement Decisions—whether to purchase capital assets to take the place of existing assets primarily to maintain existing operations.
- Expansion Decisions—whether to purchase additional capital projects to increase existing operations (grow the firm).

Project Classifications (cont.)

- Independent Projects—projects whose cash flows are not affected by decisions made about other projects.
- Mutually Exclusive Projects—a set of projects where the acceptance of one project means the others cannot be accepted.

The Post-Audit

- Compares actual results with those predicted by the project's sponsors and explains why any differences occurred
- Two main purposes:
  - To improve forecasts
  - To improve operations

Similarities between Capital Budgeting and Asset Valuation

1. Estimate the cash flows expected from the project.
2. Evaluate the riskiness of cash flows.
3. Compute the present value of the expected cash flows to obtain an estimate of the asset's value to the firm.
4. Compare the present value (PV) of the future expected cash flows (CF) with the initial investment. If (PV of CF) > (Initial Investment), purchase the asset.

Net Present Value: Sum of the PVs of Inflows and Outflows

$$NPV = \hat{CF}_0 + \frac{\hat{CF}_1}{(1+r)^1} + \frac{\hat{CF}_2}{(1+r)^2} + \cdots + \frac{\hat{CF}_n}{(1+r)^n}$$

$$= \sum_{t=0}^{n} \frac{\hat{CF}_t}{(1+r)^t}$$

NPV Decision Rule:

A project is acceptable if NPV > $0

Net Cash Flows for Project S and Project L

	Expected After-Tax Net Cash Flows, $\hat{CF}_t$	
Year (t)	Project S	Project L
0	$(3,000)	$(3,000)
1	1,500	400
2	1,200	900
3	800	1,300
4	300	1,500

Cash Flow Timelines for Project S and Project L

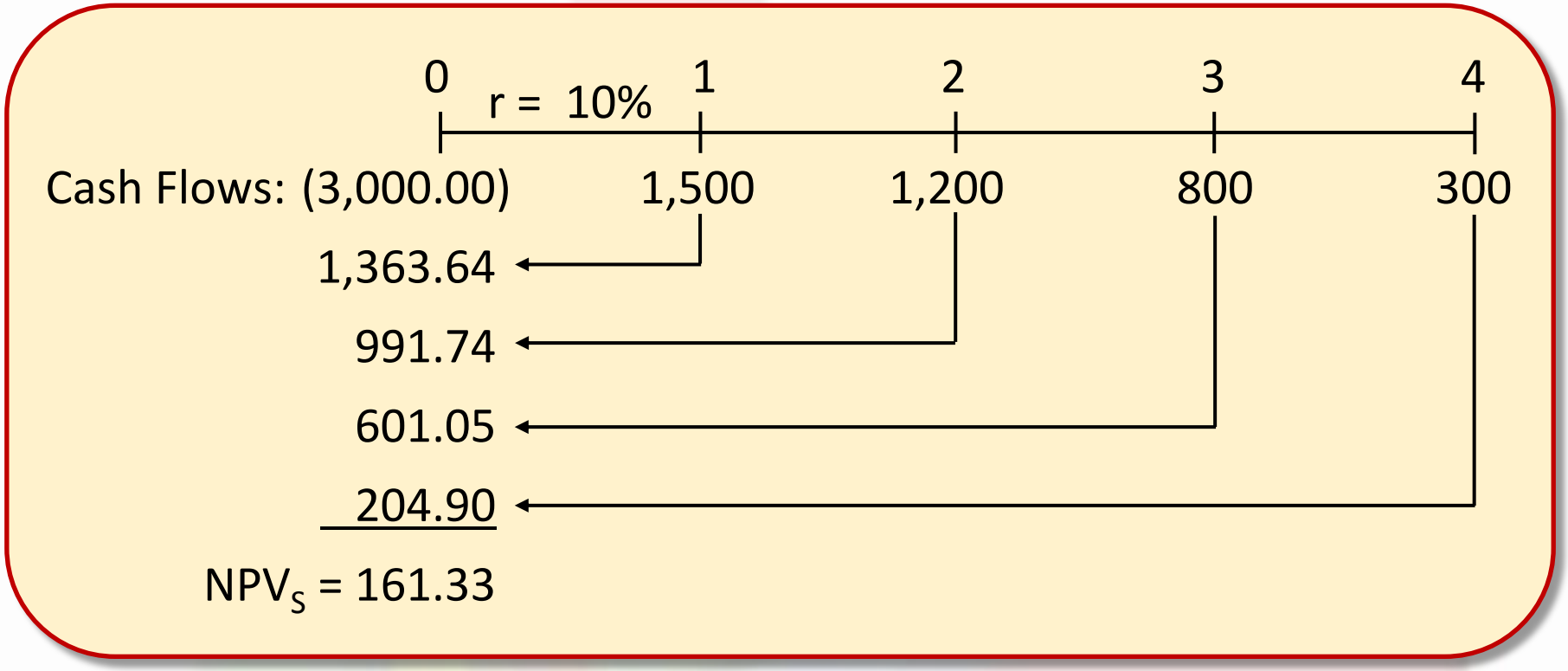
Project S:

	0	1	2	3	4
Net cash flow	(3,000)	1,500	1,200	800	300

Project L:

	0	1	2	3	4
Net cash flow	(3,000)	400	900	1,300	1,500

What is Project S's NPV?



Project S is acceptable, because its NPV is positive.

Rationale for the NPV method:

- NPV = (PV future CFs) – Cost
  = Net gain in wealth (value)
- Accept project if NPV > 0.
- Choose between mutually exclusive projects on basis of higher NPV.
- Which adds most value?

Using NPV method: Which project(s) should be accepted?

- $NPV_S = 161.33$ and $NPV_L = 108.67$
- If Projects S and L are mutually exclusive, accept Project S because $NPV_S > NPV_L$
- If Projects S and L are independent, accept both, because both have NPV > 0.

Internal Rate of Return (IRR)

- IRR is the rate of return that will be earned if a project is purchased and held for its entire life.
- IRR Decision Rule: A project is acceptable if IRR > (firm's required rate of return, r)

Calculating IRR

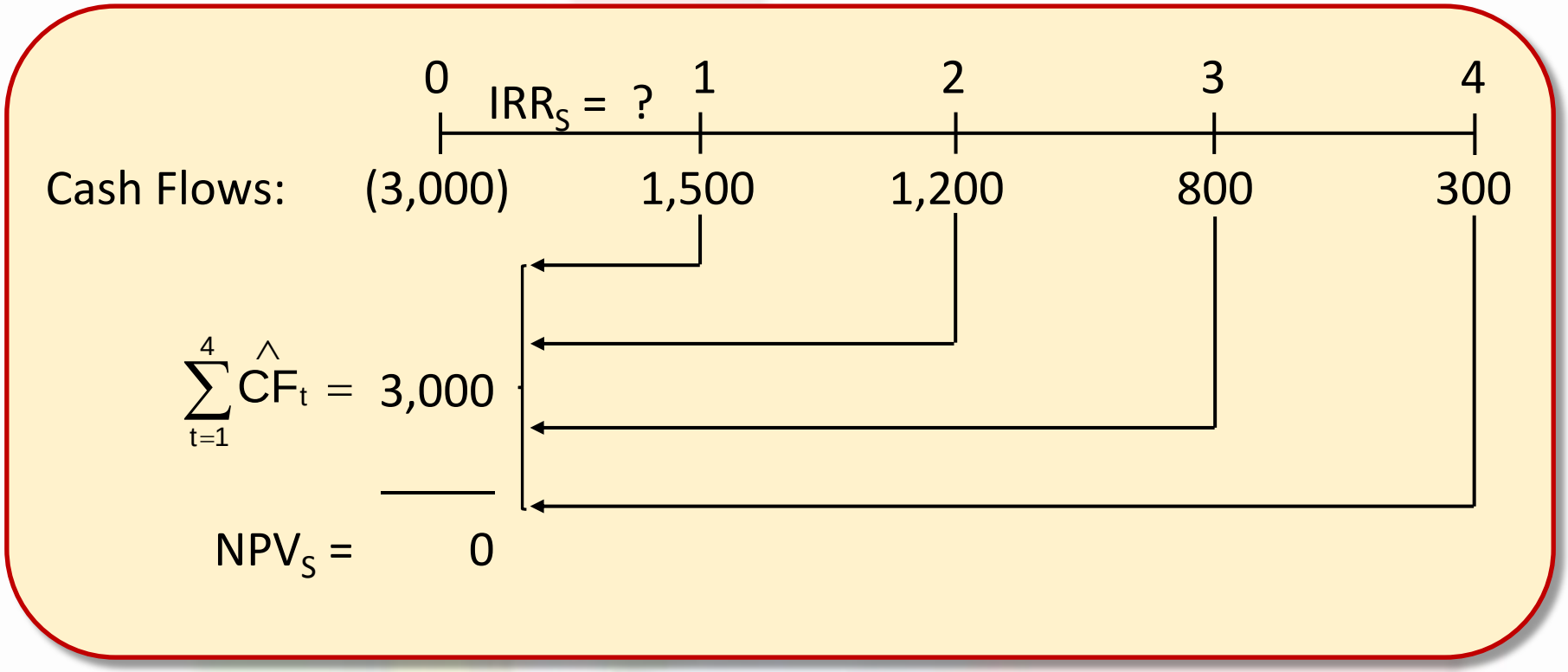
$$NPV = \hat{CF}_0 + \frac{\hat{CF}_1}{(1+IRR)^1} + \frac{\hat{CF}_2}{(1+IRR)^2} + \cdots + \frac{\hat{CF}_n}{(1+IRR)^n} = 0$$

or

$$\hat{CF}_0 = \frac{\hat{CF}_1}{(1+IRR)^1} + \frac{\hat{CF}_2}{(1+IRR)^2} + \cdots + \frac{\hat{CF}_n}{(1+IRR)^n}$$

A project is acceptable if IRR > r

Calculating the IRR for Project S



Calculating the IRR for Project S

$$(3{,}000) + \frac{1{,}500}{(1+\text{IRR})^1} + \frac{1{,}200}{(1+\text{IRR})^2} + \frac{800}{(1+\text{IRR})^3} + \frac{300}{(1+\text{IRR})^4} = 0$$

Rationale for the IRR Method

- If (project's rate of return, IRR) > (firm's required rate of return, r), then some return is left over to boost stockholders' returns.

<u>Example</u>: IRR = 13% > r = 10%; profitable

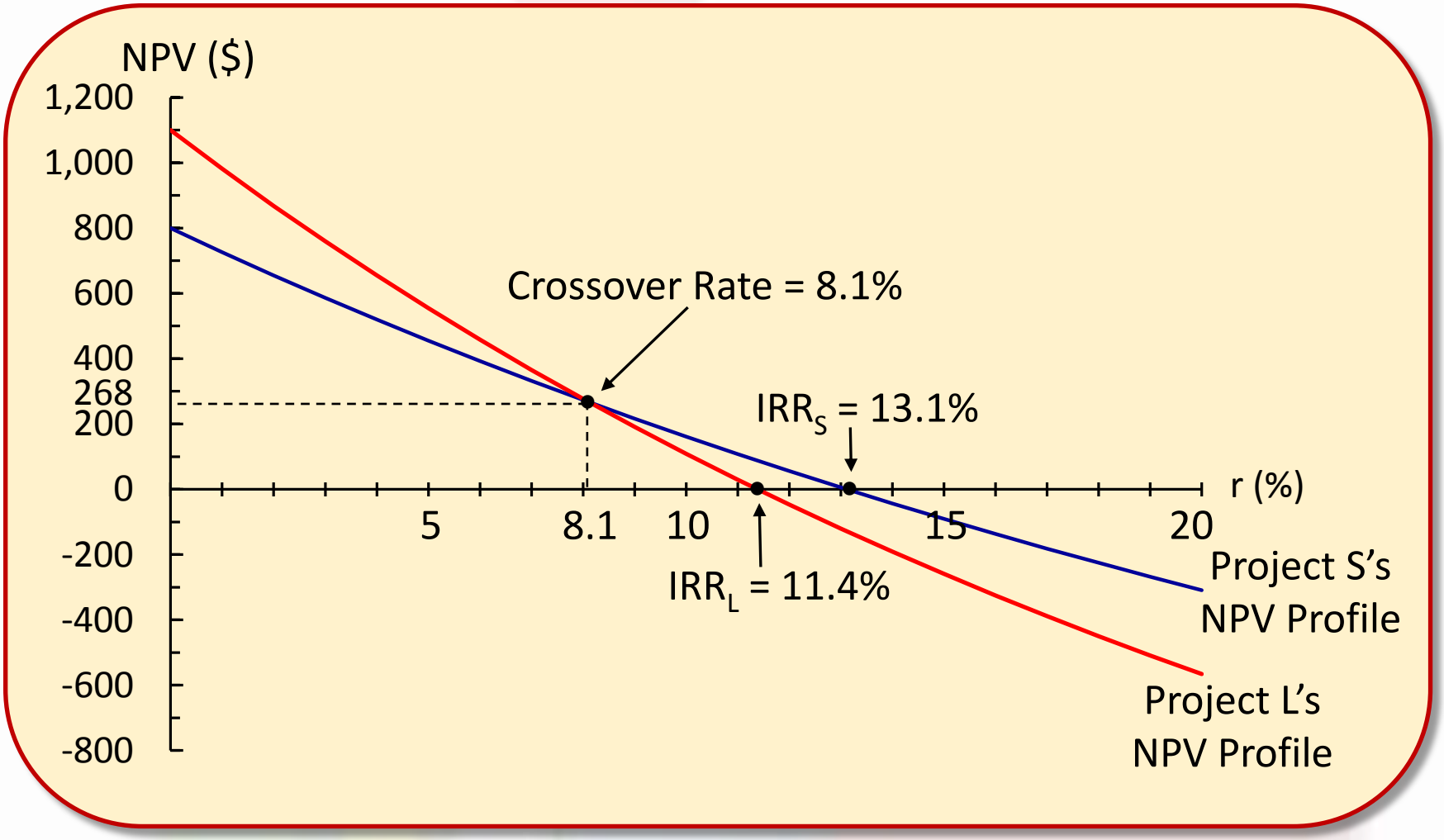
Decisions on Projects S and L per IRR

- If Project S and Project L are independent, accept both. $IRR_S = 13.1\% > IRR_L = 11.4\% > r = 10\%$.
- If Project S and Project L are mutually exclusive, *based on IRR*, Project S is more acceptable because $IRR_S > IRR_L$

NPV Profiles for Project S and Project L

Discount Rate	NPV_S	NPV_L
0%	$800.00	$1,100.00
5	454.89	554.32
10	161.33	108.67
15	(90.74)	(259.24)
20	(309.03)	(565.97)

NPV Profiles for Projects S and L



Two Reasons NPV Profiles Cross:

- Size (scale) differences: Smaller project frees up funds at t = 0 for investment. The higher the opportunity cost, the more valuable these funds; thus, high r favors small projects.
- Timing differences: Project with faster payback provides more CF in early years for reinvestment.

Reinvestment Rate Assumptions

- NPV assumes reinvest at r.
- IRR assumes reinvest at IRR.
- Reinvest at opportunity cost, r, is more realistic, so NPV method is better.
- NPV should be used to choose between mutually exclusive projects; ensures value is maximized.

Modified Internal Rate of Return

- A better indicator of relative profitability; better for use in capital budgeting
- **What is 'Modified Internal Rate Of Return - MIRR'**
  - Modified internal rate of return (MIRR) assumes that positive cash flows are reinvested at the firm's cost of capital, and the initial outlays are financed at the firm's financing cost. By contrast, the traditional internal rate of return (IRR) assumes the cash flows from a project are reinvested at the IRR. The MIRR more accurately reflects the cost and profitability of a project.
- MIRR Rule: A project is acceptable if MIRR > r

Traditional Payback Period

- The length of time it takes to recover the original cost of an investment from its expected cash flows

$$\text{Payback period} = \left(\begin{array}{c}\text{The year just } \textit{prior} \text{ to the} \\ \text{year of full recovery} \\ \text{of initial investment}\end{array}\right) + \left(\frac{\begin{array}{c}\text{Amount of the initial investment that is} \\ \textit{unrecovered} \text{ at the start of the recovery year}\end{array}}{\begin{array}{c}\text{Total cash flow generated} \\ \text{during the recovery year}\end{array}}\right)$$

Traditional Payback Period (cont.)

- PB Decision Rule: A project is acceptable if PB < n*
- n* = years determined by the firm

Payback Period (PB) for Project S

$PB_S = 2.4$

	0	1	2	3	4
Net cash flow	(3,000)	1,500	1,200	800	300
Cumulative CF	(3,000)	(1,500)	(300)	500	800

$$\text{Payback, } PB_S = 2 + \frac{300}{800} = 2.4 \text{ years}$$

Discounted Payback Period (DPB)

- The traditional payback period does not consider the time value of money; the discounted payback period does.
- DPB = the length of time it takes for a project's discounted (PV of) cash flows to repay the cost of the investment.
- DPB Decision Rule: A project is acceptable if DPB < Project's useful life.

Discounted Payback Period (DPB) for Project S

$DPB_S = 3.2$

	0	1	2	3	4
Net cash flow	(3,000)	1,500.00	1,200.00	800.00	300.00
Discounted CF	(3,000)	1,363.64	991.74	601.05	204.90
Cumulative DCF	(3,000)	(1,636.36)	(644.62)	(43.57)	161.33

$$DPB_S = 3 + \frac{43.57}{204.90} = 3.2 \text{ years}$$

DPB_S < 4 years, thus the project is acceptable.

Capital Budgeting Methods Used in Practice

- Companies use more sophisticated capital budgeting techniques today than in the past (20 – 30 years ago).
- Companies use multiple capital budgeting techniques when making investment decisions.

Cash Flow Estimation

- Most important and most difficult step in the analysis of a capital project is forecasting future cash flows.
- Financial staff's role includes:
  - Coordinating other departments' efforts.
  - Ensuring that everyone uses the same set of economic assumptions.
  - Making sure that no biases are inherent in forecasts.

Relevant Cash Flows

- Cash Flow Versus Accounting Income
  - Evaluate only after-tax cash flows
- Incremental Cash Flows
  - Evaluate only cash flows that change if the capital budgeting project is purchased.

Incremental Cash Flows

- An Incremental Cash Flow is the change in a firm's net cash flow (increase or decrease) associated with purchasing an investment (asset).

Problems in Determining Incremental Cash Flows

- Sunk Cost—a cash outlay that already has been incurred and will not be recovered if the project is purchased.
- Opportunity Cost—the return on the best alternative use of an asset.
- Externalities—the effect that purchasing a project has on the cash flows in other parts of the firm
- Shipping and Installation Costs
- Inflation

Identifying Incremental Cash Flows

- Initial Investment Outlay—the incremental cash flows that occur only at the beginning of the project's life.
  - Purchase price
  - Shipping and installation
  - Tax effect of selling an old asset
  - Change in investment in working capital

Identifying Incremental Cash Flows (cont.)

- Supplemental Operating Cash Flow—changes in cash flows that are sustained throughout the life of the asset; the cash flow effects are ongoing.
  - Change in net sales
  - Change in salaries and other operating expenses
  - Change in taxes

Identifying Incremental Cash Flows (cont.)

- Terminal Cash Flow—the cash flows associated with the project that occur only at the end of a project's life when the firm disposes of the project.
  - Salvage value
  - Tax effect of salvaging an asset
  - Change in net working capital
  - Lost opportunity to salvage a replaced asset

Supplemental Operating Cash Flow

$$\text{Supplemental operating } \hat{CF}_t = \Delta\text{Cash revenues}_t - \Delta\text{Cash expenses}_t - \Delta\text{Taxes}_t$$

$$= \Delta NOI_t \times (1 - T) + \Delta Depr_t$$

$$= (\Delta NOI_t + \Delta Depr_t) \times (1 - T) + T\Delta Depr_t$$

ΔNOI_t = change in net operating income that results from purchasing the project

$\Delta Depr_t$ = change in depreciation expense associated with the purchase of the project

T = marginal tax rate

Capital Budgeting Project Evaluation

- Expansion Project—decision as to whether to add a project that is intended to increase sales; provides growth to the firm.
- Replacement Analysis—decision as to whether to replace an existing, still productive asset with a new asset.

Expansion Project Analysis—Example: HEP Project ($000)

Purchase price	$(9,500)
Shipping and installation	$(500)
Increase in net working capital	$(4,000)
Estimated life	4 years
Salvage	$ 2,000
Increase in net sales	$30,000
Variable cost ratio	60%
Increase in overhead (excl. depr.)	$(5,000)
Marginal tax rate	40%
Depreciation method	5-year MACRS

Expansion Analysis—HEP Project: Initial Investment Outlay ($000)

Purchase price	$(9,500)
Shipping and installation	(500)
Increase in net working capital	(4,000)
Initial investment outlay	$(14,000)

Expansion Analysis—HEP Project: Supplemental Operating CFs ($000)

Δ Operating CF *before* Depreciation and Taxes	
Δ net sales	$30,000
Δ variable cost (60% of sales)	(18,000)
Δ fixed cost (excl. depr.)	(5,000)
	$ 7,000

Expansion Analysis—HEP Project: Supplemental Operating CFs ($000)

Depreciable basis = Purchase price + Shipping & install.

= $9,500 + $500 = $10,000

Year	Depreciable Basis		MACRS Rate		Annual Depreciation
2018	$10,000	x	0.20	=	$2,000
2019	10,000	x	0.32	=	3,200
2020	10,000	x	0.19	=	1,900
2021	10,000	x	0.12	=	1,200
	Accumulated depreciation			=	$8,300

Expansion Analysis—HEP Project: Supplemental Operating CFs ($000)

$$\text{Supplemental operating } \hat{CF}_t = (\Delta NOI_t + Depr_t)(1 - T) + T\Delta Depr_t$$

Year	Supplemental Operating Cash Flows
2018	$7,000(1 – 0.4) + (0.4)$2,000 = $5,000
2019	7,000(1 – 0.4) + (0.4)$3,200 = 5,480
2020	7,000(1 – 0.4) + (0.4)$1,900 = 4,960
2021	7,000(1 – 0.4) + (0.4)$1,200 = 4,680

NOTE: The $7,000 excludes depreciation; thus, depreciation should *not* be added back.

Expansion Analysis—HEP Project: Terminal Cash Flow ($000)

Selling price of asset in 2021	$2,000
Tax on sale of asset	(120)*
Return of net working capital	4,000
Terminal Cash Flow	$5,880

Book value of asset	=	Depreciable basis	–	Accumulated depreciation		
	=	$10,000	–	$8,300	=	$1,700
Gain on sale	=	Sale price	–	Book value		
	=	$2,000	–	$1,700	=	$ 300
Tax on gain	=	$300 (0.40)			=	$ 120*

Expansion Analysis—HEP Project: Cash Flows ($000)

Cash Flow	2017	2018	2019	2020	2021
Initial Investment Outlay	$(14,000)				
Supplemental Operating CFs		$5,000	$5,480	$4,960	$4,680
Terminal cash flow					5,880
Net cash flow	$(14,000)	$5,000	$5,480	$4,960	$10,560

Expansion Analysis—HEP Project: Cash Flow Timeline ($000)

	2017	2018	2019	2020	2021
Cash Flows:	(14,000)	5,000	5,480	4,960	10,560
	4,348				
	4,144				
	3,261				
	6,038				

r = 15%

NPV = $3,791 IRR = 26.3% PB = 2.7 yrs DPB = 3.4 yrs

HEP's project is acceptable, because its NPV is positive.

Replacement Analysis—HEP Project ($000)

	Old Lathe	New Machine
Purchase price	$(7,900)	$(9,500)
Remaining life	5 years	5 years
Salvage value in 5 years	$ 500	$ 2,000
Salvage value today	$ 1,600	---
Decrease in operating costs		$ 3,500
Increase in net WC	---	$(1,400)
Marginal tax rate		40%
Depreciation method	$500	3-yr MACRS

Replacement Analysis—HEP Project: Sale of Old Lathe Today ($000)

Selling price of old asset today	$1,600
Tax on sale of asset	520*
Net cash flow from selling old lathe	$2,120

Book value of asset	=	Depreciable basis	–	Accumulated depreciation		
	=	$7,900	–	10($500)	=	$2,900
Gain on sale	=	Sale price	–	Book value		
	=	$1,600	–	$2,900	=	$(1,300)
Tax on gain	=	$(1,300)0.40			=	$(520)*

* A negative tax represents a refund, which is a cash inflow.

Replacement Analysis—HEP Project: Initial Investment Outlay ($000)

Purchase price of new machine	$(12,000)
Δ Net working capital	(1,400)
Net CF from sale of old lathe	2,120
Initial investment outlay	$(11,280)

Replacement Analysis—HEP Project: Supplemental Operating CFs ($000)

Change in annual depreciation:

- Old machine depreciation = $500/year
- New machine's depreciable basis = $12,000

Year	New Machine Depreciation	Old Machine Depreciation	Δ in Depr.
2018	$3,960 = $12,000 x 0.33	$500	$3,460
2019	5,400 = 12,000 x 0.45	500	4,900
2020	1,800 = 12,000 x 0.15	500	1,300
2021	840 = 12,000 x 0.07	500	340
2022	0	500	(500)

Replacement Analysis—HEP Project: Supplemental Operating CFs ($000)

Year	Supplemental Operating Cash Flows
2018	$3,500(1 – 0.4) + (0.4)$3,460 = $3,484
2019	3,500(1 – 0.4) + (0.4)$4,900 = 4,060
2020	3,500(1 – 0.4) + (0.4)$1,300 = 2,620
2021	3,500(1 – 0.4) + (0.4)$ 340 = 2,236
2022	3,500(1 – 0.4) + (0.4)$(500) = 1,900

Replacement Analysis—HEP Project: Terminal Cash Flow ($000)

- If HEP buys the new machine, the old lathe will be sold today.
- If HEP sells the old lathe today, the company will not be able to sell it for its $400 salvage value in 2022, which means HEP will not receive $400 in 2022.
- This is a *relevant* cash flow, because the loss of the $400 salvage value results from the decision to purchase the new machine.
- Thus, $400 should be recognized as a cash outflow (loss of cash) in 2022.

Replacement Analysis—HEP Project: Terminal Cash Flow ($000)

Book value of new machine in 2022 = $0, because it will be fully depreciated.

Gain on sale of new machine = $2,000 – 0 = $2,000

Tax on sale of new machine = $2,000(0.4) = $800

Net CF from sale of *new* machine in 2022
= $2,000 – $800 = <u>$1,200</u>

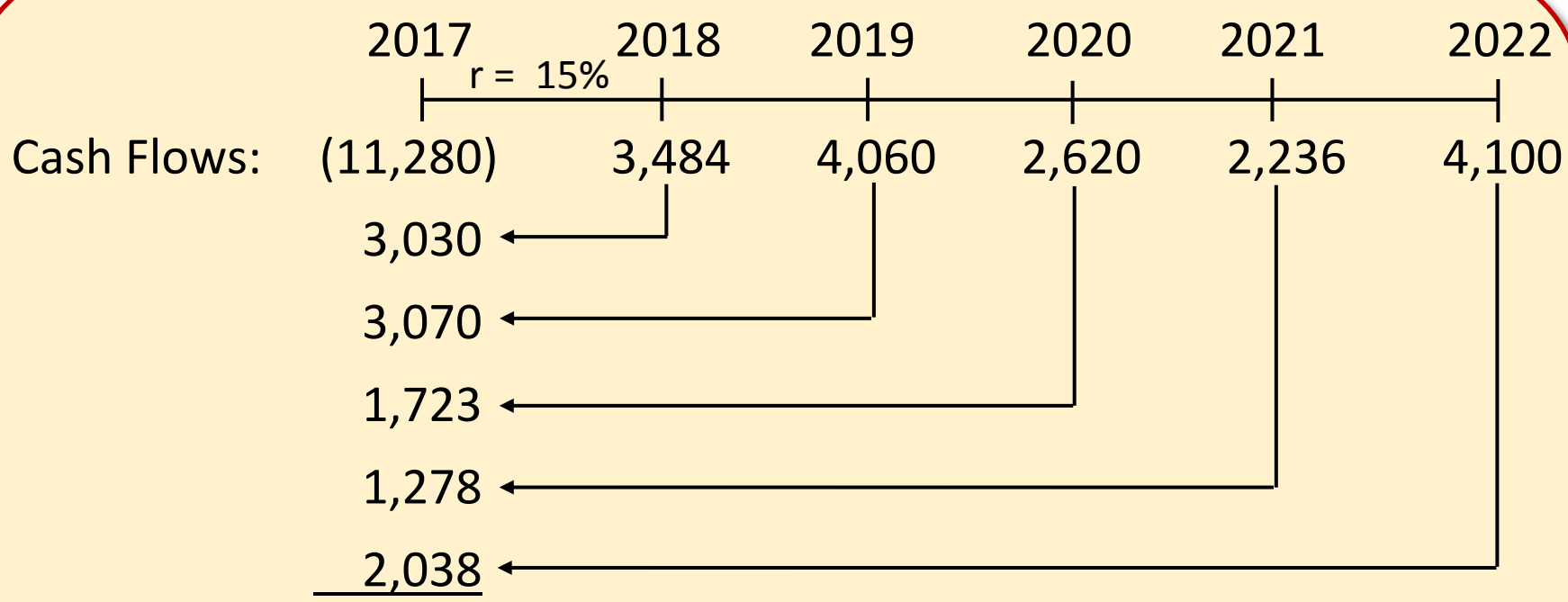
Replacement Analysis—HEP Project: Terminal Cash Flow ($000)

Net CF from sale of *new* machine	$1,200
Loss of salvage value from *old* lathe	(400)
Return on net working capital	1,400
	$2,200

Replacement Analysis—HEP Project: Cash Flows ($000)

Cash Flow	2017	2018	2019	2020	2021	2022
Initial Investment Outlay	$(11,280)					
Supplemental Operating CFs		$3,484	$4,060	$2,620	$2,236	$1,900
Terminal CF						2,200
Net cash flow	$(11,280)	$3,484	$4,060	$2,620	$2,236	$4,100

Replacement Analysis—HEP Project: Cash Flow Timeline ($000)



NPV = $(141) IRR = 14.46% PB = 3.5 yrs DPB > 5.0 yrs

HEP's replacement project is not acceptable, because its NPV < 0.

Incorporating Risk in Capital Budgeting Analysis

- Project risk should be evaluated to determine whether the appropriate required rate of return is used to compute the project's NPV (or to compare to its IRR).
- If a firm is considering a project that is much riskier than the existing assets, then it makes sense that the firm should expect to earn a higher return on the project than on its existing assets (and vice versa).

Incorporating Risk in Capital Budgeting Analysis

- *Stand-alone risk*—risk of the asset when it is held in isolation—that is, when it stands alone
- *Corporate, or within-firm, risk*—measured by the impact an asset is expected to have on the operations of the firm—that is, how an asset will affect the firm's total risk if it is purchased and added to existing assets
- *Beta, or market, risk*—the portion of an asset's risk that cannot be eliminated through diversification—that is, how an asset will affect the firm's market risk, or beta, if it is purchased and added to existing assets.

Techniques for Measuring Stand-Alone Risk

- Sensitivity analysis—key variables are changed and the resulting changes in the NPV and the IRR are observed.

Deviation from Base Case (%)	Operating Expense Savings per Year		Required Rate of Return (r)	
	NPV	% Δ	NPV	% Δ
-10	$(421.29)	(237%)	$519.27	69%
0	307.68	0	307.68	0
10	1,036.64	237	99.85	(68)

Operating expenses show greater sensitivity than the required rate of return.

Techniques for Measuring Stand-Alone Risk

- Scenario analysis—compute outcomes using various circumstances, or scenarios.

Scenario	Savings	NPV	Probability	NPV x *Pr*
Best case	$10,000	$3,953	0.2	$790.60
Base case	8,000	308	0.7	215.60
Worst case	6,000	(3,337)	0.1	(333.70)
			Expected NPV =	672.50
			σ_{NPV} =	1,962.89
			CV_{NPV} =	2.92

To determine the appropriate rate of return, compare the project's CV to the CV of an average-risk project.

Techniques for Measuring Stand-Alone Risk

- Monte Carlo simulation—try to simulate the real world by identifying all the possible outcomes for all the situations, or variables, that are associated with a capital budgeting project along with the probabilities that these outcomes will occur.

Corporate (Within-Firm) Risk

- Determine how a capital budgeting project is related to the existing assets of the firm.
- If the firm wants to diversify its risk, it will try to invest in projects that are negatively related (or have little relationship) to the existing assets.
- If a firm can reduce its overall risk, then it generally becomes more stable and its required rate of return decreases.

Beta (or Market) Risk and Required Rate of Return for a Project

- Theoretically any asset has a beta, β, or some way to measure its systematic risk
- If we can determine the beta of an asset, then we can use the capital asset pricing model, CAPM, to compute its required rate of return as follows:

$$r_{proj} = r_{RF} + (r_M - r_{RF})\beta_{proj}$$

- Measuring beta risk for a project—it is difficult to determine the beta for a project.
  - *Pure play method*—identify companies whose only business is the project in question.

Beta (or Market) Risk and Required Rate of Return for a Project

- Capital budgeting project characteristics:

  Cost = \$100,000 $\beta_{project}$ = 1.5

  r_{RF} = 3.0% r_M = 9.0%

  $r_{project}$ = 3.0% + (9.0% - 3.0%)1.5 = 12.0%

- Firm's characteristics before purchasing the project:

  Total assets = \$400,000 β_{firm} = 1.0

- Firm's beta coefficient after purchasing the project:

  Total assets = \$400,000 + \$100,000 = \$500,000

$$\beta_{Firm\text{-}new} = 1.0\left(\frac{400{,}000}{500{,}000}\right) + 1.5\left(\frac{100{,}000}{500{,}000}\right) = 1.1$$

How Project Risk Is Considered in Capital Budgeting Decisions

- Most firms use a risk-adjusted discount (RAD) rate
  - It is equal to the risk-free rate of interest plus a risk premium.
  - The average required rate of return is adjusted for projects with above-average or below-average risks.

Risk Category	Project Required Rate of Return
Above-average	16%
Average	12
Below-average	10

Multinational Capital Budgeting

- For the most part, the capital budgeting projects of multinational firms should be evaluated the same as for domestic firms.

Multinational Capital Budgeting

- Repatriation of cash (earnings) might be restricted; foreign governments might limit the cash that the firm can transfer to other countries.
- Projects associated with foreign operations often are considered riskier than domestic projects:
  - Exchange rate risk—affects the translation of foreign currency into domestic currency
  - Political risk—a government might takeover (expropriate) or severely restrict operations of foreign subsidiaries in its country

Cost of Capital

- Represents the firm's average cost of funds, which is the average return required by firm's investors.
- What must be paid to attract funds.
- The return that must be earned on invested funds to cover the cost of using those funds.
- The firm's required rate of return, r

Cost of Capital

- Investors who are the participants in the financial markets determine the firm's costs of funds.
- The firm's costs of funds change when
  - conditions in the financial markets change.
  - investors' general risk aversion changes.
  - firm's risk changes.

Basic Definitions

- Capital Components
  - Types of capital used by firms to raise money
    - r_d = before tax interest cost (cost of debt)
    - r_{dT} = $r_d(1 – T)$ = after-tax cost of debt
    - r_{ps} = cost of preferred stock
    - r_s = cost of retained earnings
    - r_e = cost of external equity (new stock)

Basic Definitions

- WACC
  - Weighted average cost of capital
- Capital Structure
  - The combination of the different types of capital (debt and equity) used by a firm.

Cost of Debt, r_{dT}

- The relevant cost of new debt
- Must account for the tax deductibility of interest
- r_d = before-tax cost of debt = yield to maturity (YTM), which is the return required by investors

$$\begin{aligned}\text{After-tax component cost of debt} = r_{dT} &= \begin{pmatrix}\text{Bondholders'}\\ \text{required}\\ \text{rate of return}\end{pmatrix} - \begin{pmatrix}\text{Tax}\\ \text{savings}\end{pmatrix}\\ &= r_d - r_d \times T\\ &= r_d(1 - T)\end{aligned}$$

Cost of Debt, r_{dT}—Example

A firm that currently has debt with the following characteristics wants to issue new debt to raise funds to support its future growth.

Maturity value, M	$1,000
Coupon rate, C	9.0% (paid semiannually)
Years to maturity	12 yrs
Market price	$931
Marginal tax rate	40%

Cost of Debt, r_{dT}—Example

Based on the preceding information, we know that the following relationship exists:

$$V_d = \$931 = \frac{\$45}{(1+r_d)^1} + \frac{\$45}{(1+r_d)^2} + \text{L} + \frac{\$1,000+\$45}{(1+r_d)^{24}}$$

Solving for r_d gives us the YTM for this bond

Cost of Debt, r_{dT}—Example

Financial calculator solution:

N	=	24	=	12 years x 2
PV	=	-931		
PMT	=	45	=	(0.09 x 1,000)/2
FV	=	1,000		

Inputs:	24	?	-931	45	1,000
	N	I/Y	PV	PMT	FV

Output: = 5% = $r_d/2$

Cost of Debt, r_{dT}—Example

- Because interest is paid every six months, the computation of the before-tax cost of debt is based on semiannual compounding.
- Thus, $r_d/2 = 5\%$ is the six-month rate of return.
- The annual rate, $r_d = 5\% \times 2 = 10\%$
- If the firm's marginal tax rate is 40 percent,

$$r_{dT} = 10\%(1 - 0.4) = 10\%(0.6) = 6\%$$

Cost of Equity

- The cost of equity is based on the rate of return required by the firm's stockholders.
  - Cost of preferred stock—dividends received by preferred stockholders represent an annuity
  - Cost of retained earnings (internal equity)—return that common stockholders require the firm to earn on the funds that have been retained, thus reinvested in the firm, rather than paid out as dividends
  - Cost of new (external) equity—rate of return required by common stockholders after considering the cost associated with issuing new stock (flotation costs)

Cost of Preferred Stock, r_{ps}

- Rate of return investors require on the firm's preferred stock:

$$\text{Component cost of preferred stock} = r_{ps} = \frac{D_{ps}}{NP_0} = \frac{D_{ps}}{P_0 - \text{Flotation costs}}$$

$$= \frac{D_{ps}}{P_0(1-F)}$$

F = percentage flotation costs stated as a decimal

NP_0 = per share net proceeds the firm receives from the issue

Cost of Preferred Stock, r_{ps}—Example

- A firm has preferred stock with the following characteristics:

Market price, P_0	\$120.00
Dividend, D_{ps}	\$12.80
Flotation cost, F	3.0%

$$r_{ps} = \frac{\$12.80}{\$120(1-0.03)} = \frac{\$12.80}{\$116.40} = 0.11\% = 11.0\%$$

- There is *no tax adjustment*, because payment of dividends is not a tax-deductible expense.

Cost of Retained Earnings, r_s

- The firm must earn a return on reinvested earnings that is sufficient to satisfy existing common stockholders' investment demands.
- If the firm does not earn a sufficient return using retained earnings, then the earnings should be paid out as dividends.

Cost of Retained Earnings, r_s

- Assuming the stock market is at or near equilibrium, we know that the following relationship exists:

$$\text{Required rate of return} = \text{Expected rate of return}$$

$$r_s = r_{RF} + RP_s = \frac{\hat{D}_1}{P_0} + g = \hat{r}_s$$

r_{RF}	= risk-free rate of return	g	= constant growth rate
RP_s	= risk premium for Stock S	P_0	= current stock price
$\hat{D}_1$	= next period's expected dividend		

Cost of Retained Earnings, r_s—The CAPM Approach

$$r_s = r_{RF} + RP_s$$

$$= r_{RF} + RP_M \beta_s$$

$$= r_{RF} + (r_M - r_{RF})\beta_s$$

RP_M = risk premium for the market (average-risk stock)

r_M = market (average-risk stock) return

Cost of Retained Earnings, r_s—The CAPM Approach: Example

$$r_s = r_{RF} + (r_M - r_{RF})\beta_s$$

Suppose r_{RF} = 6.0%, r_M = 10.5%, and β_s = 1.6

$$r_s = 6.0\% + (10.5\% - 6.0\%)1.6 = 13.2\%$$

- Assumes the firm's stockholders are very well diversified.

Cost of Retained Earnings, r_s—The Discounted Cash Flow (DCF) Approach ($\hat{r}_s$)

$$r_s = \hat{r}_s = \frac{\hat{D}_1}{P_0} + g = \begin{pmatrix}\text{Dividend}\\ \text{yield}\end{pmatrix} + \begin{pmatrix}\text{Capital}\\ \text{gain}\end{pmatrix}$$

Cost of Retained Earnings, r_s—The Discounted Cash Flow (DCF) Approach ($\hat{r}_s$): Example

- A firm, which is growing at a constant rate of 7.5 percent, is expected to pay a dividend equal to $1.28 at the end of the year; its stock currently sells for $22.

$$r_s = \frac{\$1.28}{\$22} + 0.075 = 0.058 + 0.075 = 0.133 = 13.3\%$$

Cost of Retained Earnings, r_s—The Bond-Yield-Plus-Premium Approach

- Studies have shown that the return on equity for a particular firm is approximately 3 to 5 percentage points higher than its r_d (before-tax cost of debt).
- As a general *rule of thumb*, firms estimate r_s by adding 3 to 5 percent to r_d.
- If r_d = 10.0%, then, we might estimate the cost of retained earnings as

$$r_s \approx r_d + 4\% = 10\% + 4\% = 14.0\%$$

Cost of Retained Earnings, r_s

- The three approaches we used to determine the cost of retained earnings give three different results.
- The three approaches are based on different assumptions:
  - CAPM approach assumes investors are extremely well diversified.
  - DCF approach assumes the firms grows at a constant rate.
  - Bond-yield-plus-risk-premium approach assumes that the return on equity is related to r_d.

Cost of Retained Earnings, r_s (cont.)

- Ideally all three approaches should give the same result; if not, however, we might average the results:

$$r_s = (13.2\% + 13.3\% + 14\%)/3 = 13.5\%$$

Cost of Newly Issued Common Stock, r_e (External Equity)

- r_e = rate of return required by common stockholders after considering the costs associated with issuing new stock (*flotation costs)*.

$$r_e = \frac{\hat{D}_1}{P_0(1-F)} + g = \frac{\hat{D}_1}{NP_0} + g$$

F = percentage flotation cost stated as a decimal

- The cost of new equity is greater than the cost of retained earnings—that is, $r_e > r_s$—because the firm must pay flotation costs to issue new stock.

Cost of Newly Issued Common Stock, r_e (External Equity); Example

- A firm, which is growing at a constant rate of 7.5 percent, is expected to pay a dividend equal to $1.28 at the end of the year; its stock currently sells for $22. When it issues new common stock, the firm pays its investment banker 17 percent of the issue.

$$r_s = \frac{\$1.28}{\$22(1-0.17)} + 0.075 = \frac{\$1.28}{\$18.26} + 0.075$$

$$= 0.070 + 0.075 = 0.145 = 14.5\%$$

Target Capital Structure

- Optimal Capital Structure
  - Percentage of debt, preferred stock, and common equity in the capital structure that will maximize the price of the firm's stock.

Weighted Average Cost of Capital, WACC

- To make decisions about capital budgeting projects, we need to combine the various costs of capital—debt, preferred stock, and common stock—into a single required rate of return.
- *Weighted average cost of capital, or WACC*—the weighted average of the component costs of capital using as the weights the proportion each type of financing that makes up the total financing of the firm.

Weighted Average Cost of Capital, WACC

$$WACC = w_d r_{dT} + w_{ps} r_{ps} + w_s (r_s \text{ or } r_e)$$

w_d = proportion of debt in firm's capital structure

w_{ps} = proportion of preferred stock in firm's capital structure

w_s = proportion of common equity in firm's capital structure

Weighted Average Cost of Capital, WACC: Example

- Suppose our illustrative firm has the following capital structure:

Type of Financing	Percent of total	*After-Tax* Cost, r
Debt, d	45.0	6.0%
Preferred stock, ps	5.0	11.0
Common equity, s	50.0	13.5 or 14.5
	100.0	

Weighted Average Cost of Capital, WACC: Example

- If the firm can use *retained earnings* to finance new projects (i.e., it does not have to issue new stock)

  $WACC_1 = 0.45(6.0\%) + 0.05(11.0\%) + 0.50(13.5\%) = 10.0\%$

- If the firm must issue *new common stock* to finance new projects

  $WACC_2 = 0.45(6.0\%) + 0.05(11.0\%) + 0.50(14.5\%) = 10.5\%$

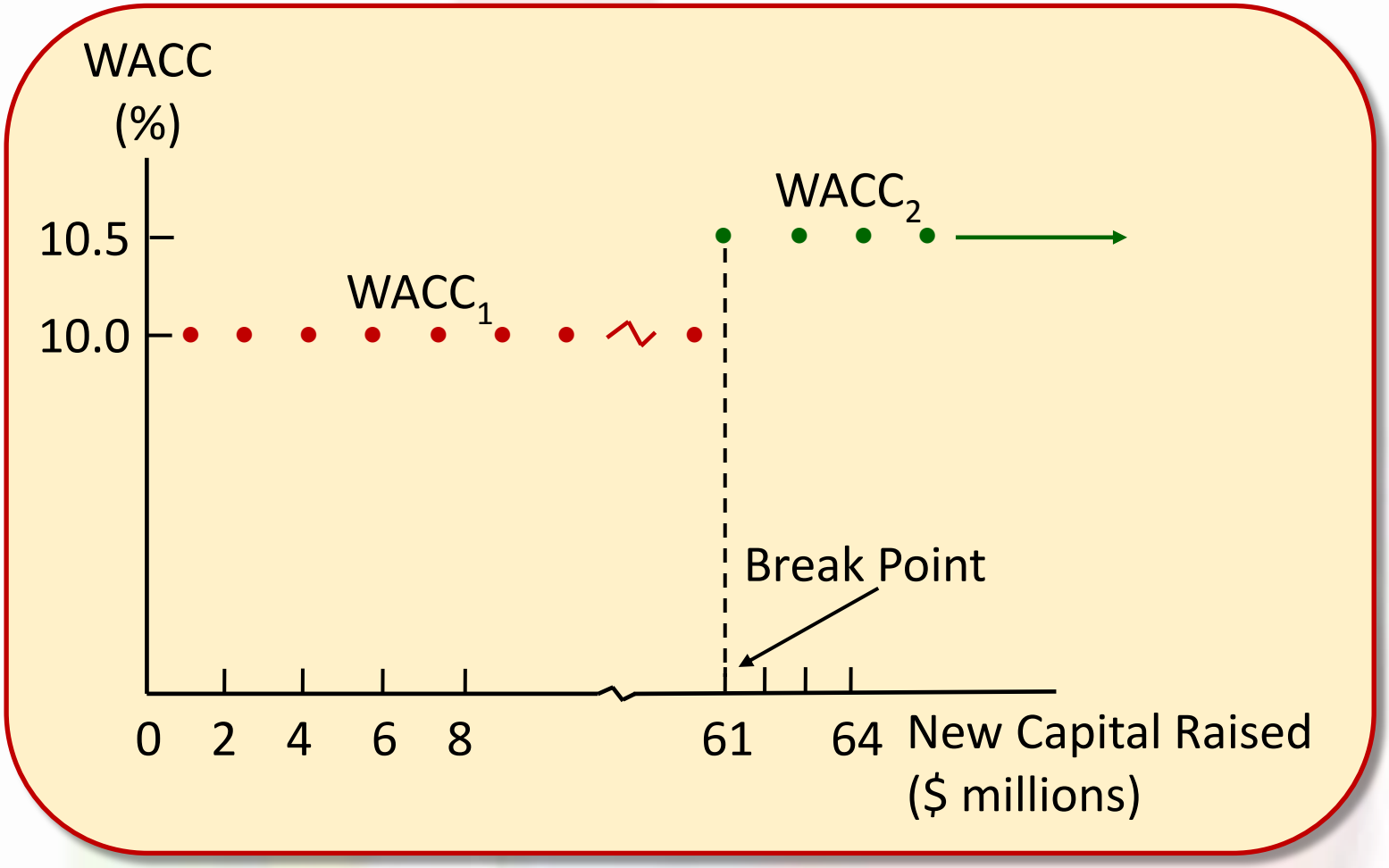
The Logic of the Weighted Average Cost of Capital

- The use of debt impacts the ability to use equity, and vice versa; so the weighted average cost must be used to evaluate projects, regardless of the specific financing used to fund a particular project.

Marginal Cost of Capital, MCC

- Weighted average cost of raising *additional* funds.
- Generally, MCC often is greater than the existing WACC—that is, the cost of new funding increases—because the
  - firm's risk increases as more funds are raised, which causes investors to require a higher rate of return.
  - costs of issuing new funds increase.
- MCC schedule—a graph that shows the average cost of funds at various levels of new financing .

MCC Schedule for Unilate Textiles If It Generates $30.5 million Retained Earnings



Break Point (BP)

- A break point occurs when WACC increases, which is caused by an *increase* in any of the component costs of capital
- Costs of funds often increase as the firm uses significantly higher amounts capital—*risk increases*.

Break Point (BP)

$$\text{Break point} = \frac{\left(\begin{array}{c}\text{Maximum amount of } \textit{lower} \text{ cost} \\ \text{of capital of a given type}\end{array}\right)}{\left(\begin{array}{c}\text{Proportion of the type of capital} \\ \text{in the capital structure}\end{array}\right)}$$

MCC Schedule for Unilate: Example

- Plans to generate $30.5 million in retained earnings this year.
- Can borrow in the following increments:

Amount of Debt	Before-Tax Cost, r_d
$1 – $54 million	10.00%
> $54 million	11.85

MCC Schedule for Unilate: Example

- Two break points exist:
  - After the $30.5 million of retained earnings is exhausted, new common stock must be issued to raise additional funds, which increases the cost of equity.
  - If the firm needs to issue more than $54 million in debt, the cost of debt increases.

MCC Schedule for Unilate: Example

- Break point associated with retained earnings, BP_{RE}

$$BP_{RE} = \frac{\$30,500,000}{0.50} = \$61,000,000 \text{ in total funds}$$

- Break point associated with debt, BP_{debt}

$$BP_{Debt} = \frac{\$54,000,000}{0.45} = \$120,000,000 \text{ in total funds}$$

MCC Schedule for Unilate: Example

- Break Points

  BP_{RE} = \$61,000,000 Bp_{debt} = \$120,000,000

- WACC if the new funds range from \$1 to \$61,000,000

Capital Source	Breakdown of Funds if \$61,000,000 is Raised	Weight of Capital	×	After-Tax Cost*	=	WACC
Debt, r_{dT1}	\$27,450,000	0.45	×	6.0%	=	2.70%
Preferred stock, r_{ps}	3,050,000	0.05	×	11.0	=	0.55
Common equity, r_s	30,500,000	0.50	×	13.5	=	6.75
	\$61,000,000	1.00		$WACC_1$	=	10.00%

* r_{dT} = 10%(1 – 0.4) = 6.0%

MCC Schedule for Unilate: Example

- Break Points

  BP_{RE} = \$61,000,000 Bp_{debt} = \$120,000,000

- WACC if the new funds range from \$61,000,001 to \$120,000,000

Capital Source	Breakdown of Funds if \$120,000,000 is Raised	Weight of Capital	×	After-Tax Cost*	=	WACC
Debt, r_{dT1}	\$ 54,000,000	0.45	×	6.0%	=	2.70%
Preferred stock, r_{ps}	6,000,000	0.05	×	11.0	=	0.55
Common equity, r_e	60,000,000	0.50	×	14.5	=	7.25
	\$120,000,000	1.00		$WACC_2$	=	10.50%

* r_{dT} = 10%(1 – 0.4) = 6.0%

r_s changed to r_e because new common equity must be issued.

MCC Schedule for Unilate: Example

- Break Points

  BP_{RE} = \$61,000,000 Bp_{debt} = \$120,000,000

- WACC if the new funds greater than \$120,000,000

Capital Source	Breakdown of Funds if \$130,000,000 is Raised	Weight of Capital	×	After-Tax Cost*	=	WACC
Debt, r_{dT1}	\$ 58,500,000	0.45	×	7.1%	=	3.20%
Preferred stock, r_{ps}	6,500,000	0.05	×	11.0	=	0.55
Common equity, r_s	65,000,000	0.50	×	14.5	=	7.25
	\$130,000,000	1.00		$WACC_3$	=	11.00%

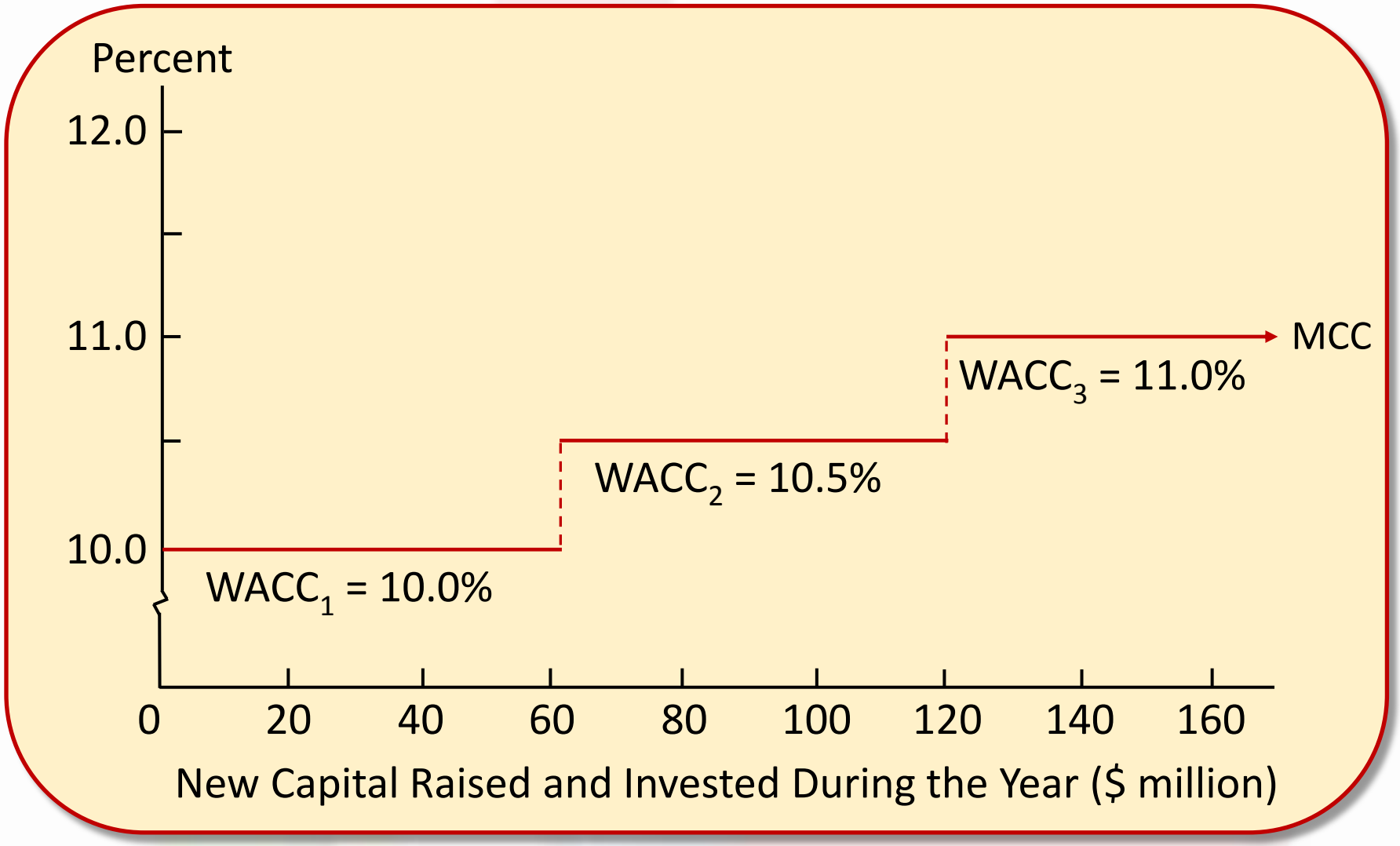
* r_{dT} = 11.85%(1 – 0.4) = 7.1%

r_{dT} changed because debt greater than \$54 million must be issued.

Combining the MCC and Investment Opportunity Schedules

- Use the MCC schedule to find the specific cost of capital for determining projects' net present values.
- Investment Opportunity Schedule (IOS)
  - Graph of the firm's investment opportunities ranked in order of the projects' internal rate of return.

Unilate's MCC Schedule

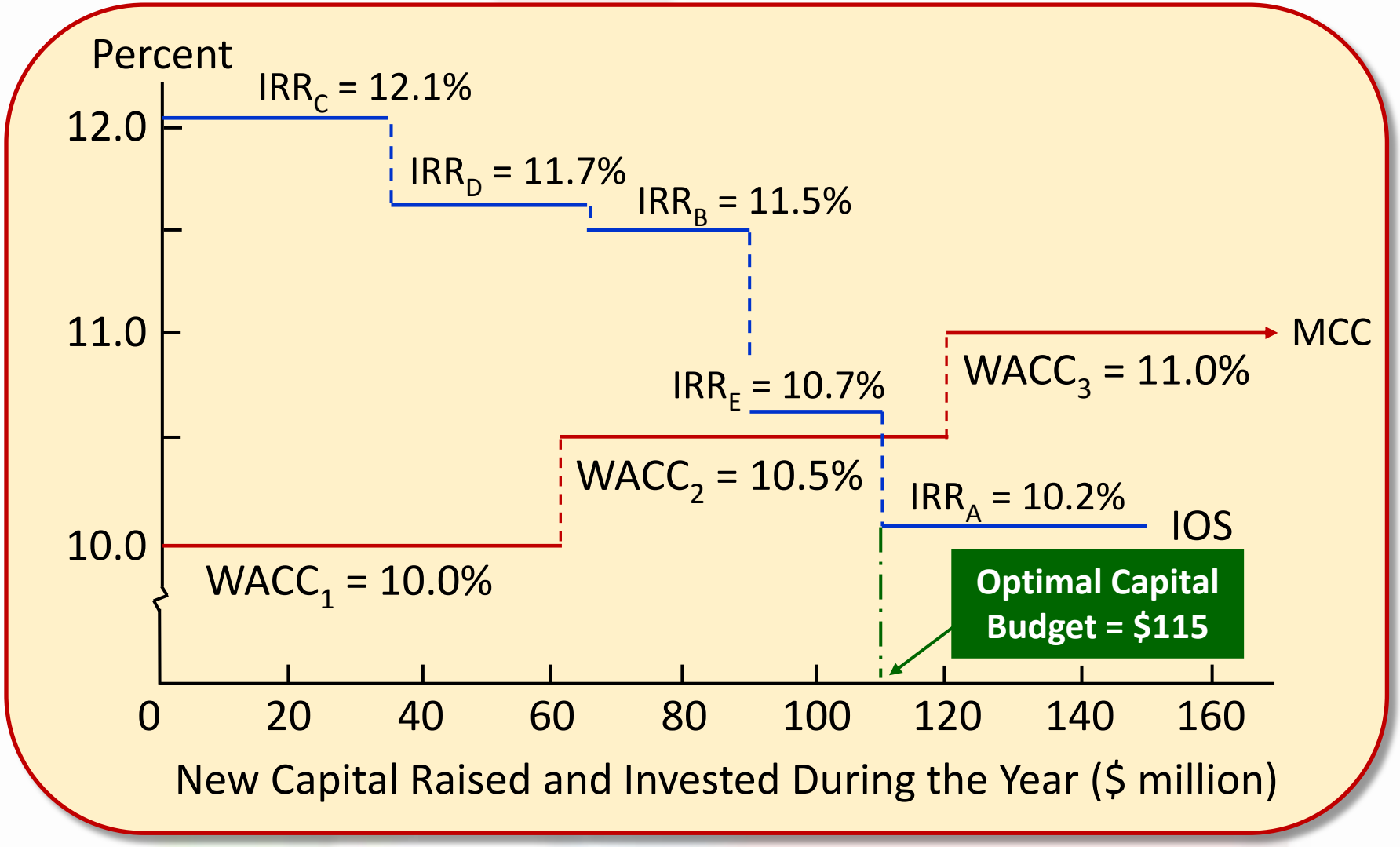


Combining Unilate's MCC and Investment Opportunity Schedules

Unilate has the following investment opportunities:

Project	Initial Cost ($ millions)	Cash Flows ($ millions)	Life (years)	IRR
A	$39	$9	6	10.2%
B	25	6	6	11.5
C	36	10	5	12.1
D	29	7	6	11.7
E	25	8	4	10.7

Combining the MCC and Investment Opportunity Schedules (IOS)



WACC versus Investors' Required Rates of Return—Debt

Return to Investors: r_d = YTM = investors' required rate of return

Cost to Firms: r_d = YTM = before-tax cost of debt

$r_{dT} = r_d(1 - T)$ = after-tax cost of debt

WACC versus Investors' Required Rates of Return—Equity

Return to Investors: $r_s = \frac{D_0(1+g)}{P_0} + g$ = investors' required rate of return

Cost to Firms: $r_s = \frac{D_0(1+g)}{P_0} + g$ = cost of retained earnings

$r_e = \frac{D_0(1+g)}{P_0(1-F)} + g$ = cost of new common equity

When g = 0, r_s = investors' required return for preferred stock, and r_e = cost of issuing preferred stock, which is r_{ps}.