Kellogg Consulting Club Finance Primer

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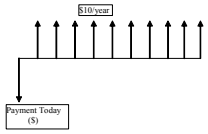
What's the Problem?

- Suppose that I offered to pay you $10 per year on November 12 for the next 10 years, starting in one year.
- How much would you pay me TODAY for this offer?



Topics

- Discounting cashflows
- Investment evaluation
- Calculating FREE CASHFLOWS including TERMINAL VALUES
- Discount rates
- Assessing a company's financial health

One Summary Slide

- Net Present Value

$$NPV = \sum_{t=1}^{T} \frac{\text{Expected Free Cashflow}_t}{(1+r_{Expected})^t}$$

- FCF = Revenues - Operating Expenses - Depreciation - Taxes + Depreciation - NWC Increase - Capital Expenditures
- $r_{Expected} = r_f + \beta(r_{Market} - r_f)$ where β reflects systematic risk
- Where are the problems/opportunities?

$$ROE = \frac{Sales}{Assets} \; x \; \frac{Net\,Profit}{Sales} \; x \; \frac{Assets}{Stockholder's\,Equity}$$

Discounted Cash Flow Analysis (also known as "DCF")

$ Today *or* $ Tomorrow

- Current shareholder wealth is driven by
  - » Cashflows that come at different times in the future
  - » Cashflows that have different degrees of uncertainty and risk
- Making correct investment decisions requires consideration of both the timing and the risk of the future cashflows
- Discounted cashflow analysis allows you to compare cashflows that occur at different times and with different amounts of risk

DCF - An Example

- Consider 2 Strategies for Daimler-Chrysler
  1. Produce cheap cars in early years generating large profits today at the expense of low profits in the future
  2. Produce good cars in early years generating lower profits today but securing larger profits in the future
- Discounted cashflow analysis provides a technique for making this tradeoff

DCF: The Main Insight

- The main insight is that **one dollar today is worth more than one dollar tomorrow**
- Example: Assume your bank pays an interest rate of 6% per year. Would you rather
  A. Receive $1 today
  OR
  B. Receive $1 one year from now?

DCF: Example

- Plan A: Receive $1 today
  - » Put the money in the bank. In one year, you will have: $1 + .06 X $1 = $1.06
- Plan B: Receive $1 in one year
- Clearly Plan A is preferable to Plan B

Future Value

- Future Value: The amount of money that an investment is worth at some point in the future
- Previous Example:
  - » FV_A = $1.06 FV_B = $1.00
- Future Value = Initial Payments + Accumulated Interest

Future Value

- Future Value is defined to be the future value, as of next year, of $PV today:

$$FV = (1+r)PV = PV + rPV$$

where r is the interest rate and PV is the Present Value or initial investment

Present Value

- Present Value is the value today of a future cashflow
- Previous example: What is the PV of $1.06 received in one year?

$$\begin{aligned} FV &= (1+r)PV \\ \Rightarrow PV &= \frac{FV}{(1+r)} \\ &= \frac{\$1.06}{(1+.06)} \\ &= \$1 \end{aligned}$$

Present Value

- Alternative question: How much would I have to deposit in the bank today in order to have $1 one year from today (assume r = 6%)?

$$FV = (1+r)PV$$
$$\Rightarrow PV = \frac{FV}{(1+r)}$$
$$= \frac{\$1.00}{(1+.06)}$$
$$= \$0.9434$$

Comparison of FV and PV

Plan	Present Value	Future Value
A	$1.00	$1.06
B	$0.9434	$1.00

•Note: By either criterion (PV or FV) we prefer A to B

•Present Values and Future Values put cashflows that come at different times on a comparable basis

Key Equation

$$\mathrm{FV} = (1+\mathrm{r})\mathrm{PV}$$

$$\mathrm{PV} = \frac{\mathrm{FV}}{(1+\mathrm{r})}$$

Buzzwords

- Taking present values is know as “discounting to the present”
- r is the “discount rate” or the “opportunity cost of capital”

Interpretation of Present Value

- Two Interpretations
  1. Present value is the amount that I have to put away to have a certain amount in the future
  2. Present value is the market value today of a cash flow to be received in the future

Interpretation of Present Value

- Example: A zero coupon bond is offered for sale. It will pay no cash flows for 5 years and will pay $100,000 at the end of five years.
- What is the highest price that a buyer would pay for this bond? The PV of $100,000.
- What is the lowest price the seller would accept for this bond? The PV of $100,000.
- Conclusion: PV is the only price acceptable to both the buyer and the seller. PV is the MARKET VALUE.

Extension to Multiple Years

- How much is $1 today worth two years from today (assume r = 6%)?
  - » In the first year, $1 will turn into $1*(1+.06) = $1.06
  - » In the second year, $1.06 will turn into $1.06*(1+.06) = $1.1236
  - » Therefore, FV = PV*$(1+r)^2$

Extension to Multiple Years

- In general, $FV = (1+r)^n PV$

  where n is the number of years

- Similarly, $PV = \frac{FV}{(1+r)^n}$

Examples: Multiple Years

- Suppose that the interest rate is 6%. What is the future value of $1 20 years from today?

$$FV = (1+r)^n PV$$

In this example, PV=$1, n=20, r=6%

Therefore, FV = $1*$(1+.06)^{20}$ = $3.21

Example: Multiple Years

- Suppose that the interest rate is 6%. What is the present value of $1000 received 15 years from today?

$$PV = \frac{FV}{(1+r)^n}$$

In this example, FV=$1000, n=15, r=6%

Therefore, $PV = \frac{1000}{(1+.06)^{15}} = \$417.27$

Example

- Suppose the interest rate is 12% and you are offered the following two options. Which option do you prefer?
  - » A. Receive $500 2 years from today
  - » B. Receive $750 6 years from today

Example

- Solution: Put the two investments on a comparable basis…calculate the present values

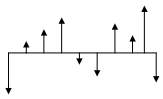
$$PV_A = \frac{500}{(1+.12)^2} = \$398.60$$

$$PV_B = \frac{750}{(1+.12)^6} = \$379.97$$

- Even though the nominal payoff from Plan B is greater, it is worth less because it is obtained further in the future. This is the **Time Value of Money**

Future and Present Value Addition

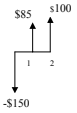
- Suppose that you want to find the FV or the PV of a number of different cashflows that occur at different times



- The present value of a stream of cashflows is equal to the sum of the present values of the individual cashflows

Example: Present Value Addition

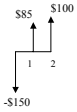
- Assume an interest rate of 8% and calculate the PV of the following cashflows



$$PV = -150 + \frac{85}{(1+.08)^1} + \frac{100}{(1+.08)^2}$$
$$= -150 + 78.70 + 85.73 = \$14.43$$

Example: Future Value Addition

- Assume an interest rate of 8% and calculate the FV of the following cashflows as of the end of year 2



$$FV = -150(1.08)^2 + 85(1.08)^1 + 100$$
$$= -174.96 + 91.80 + 100.00 = \$16.84$$

Example: Consistency Check

- What is the PV at time 0 of $16.84 in two years?

$$PV = \frac{16.84}{(1+.08)^2} = \$14.43$$

Net Present Value (NPV)

- The NPV of a project is the present value of future cashflows net of the initial investment
- If the NPV is positive, the project creates shareholder value and should be accepted
- If NPV is negative, the project destroys shareholder value and should be rejected

Internal Rate of Return

- The internal rate of return (IRR) is the discount rate that makes the NPV of a stream of cashflows equal to zero
- Stated differently, IRR is the discount rate which causes the value of future cashflows to equal the initial investment
- For a given set of future cashflows C_0, C_1, C_2,…,C_n, and initial investment P, IRR is the rate "r" that solves:

$$P = C_0 + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_n}{(1+r)^n}$$

Example: IRR

- Find the IRR for a project with the following cash flows, an initial investment of $150, and future cashflows of:
  - » C1 = $85
  - » C2 = $100

$$0 = -150 + \frac{85}{(1+r)} + \frac{100}{(1+r)^2}$$

$$\Rightarrow \text{IRR} = 14.76\%$$

Perpetuities

- A special case of multiple cash flows: a perpetuity is a constant cashflow stream that lasts forever

- The present value of a perpetuity is equal to:

$$PV_t = \sum_{t+1}^{\infty} \frac{C}{(1+r)^t} = \frac{C}{r}$$

Example: Perpetuity

- Assume an interest rate of 10%. What is the present value of a $150 perpetuity?

$$\text{PV} = \frac{150}{.10} = \$1500$$

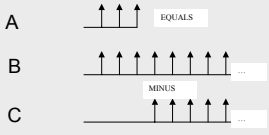
Annuities

- An annuity is like a perpetuity except that the cashflows occur over a finite (not infinite) period of time
- The present value of an annuity can be calculated:
  - » Using the annuity formula
  - » Using the perpetuity formula + the present value formula
  - » Using Excel
- Annuity Formula:

$$\text{PV} = \frac{C}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

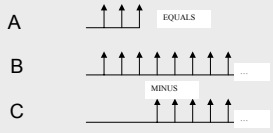
Derivation of the Annuity Formula

- The perpetuity formula can be used to derive the annuity formula (it's a good check of your understanding of PV addition)



- $PV_A = PV_B - PV_C$

Annuity Formula Derivation (continued)



$$\text{PV}_A = \frac{C}{r} - \left[\frac{1}{(1+r)^n}\right]\frac{C}{r}$$

$$= \frac{C}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

Annuities (continued)

- Therefore, the present value of an annuity is equal to the annuity multiplied by the annuity factor:

$$\frac{1}{r}\left[1-\frac{1}{(1+r)^n}\right]$$

Example #1: Annuities

- How much do you need to deposit in the bank today in order to guarantee yourself payments of $5000 per year for the next 25 years, starting at the end of this year. Assume r = 7.5%.
  - » To answer this question, you need to calculate the present value of the annuity
  - » PMT = $5000, n=25, r=7.5%

$$PV = \frac{5000}{.075}\left[1-\frac{1}{(1+.075)^{25}}\right]$$
$$= \$55{,}734.73$$

Example #1: Annuities

- Interpretation
  - » If you deposited $55,734 today, you would be able to withdraw $5000 every year for the next 25 years
  - » At the end of 25 years, you would have $0 left in your account

Example #2: Annuities

- Suppose that in order to buy a new car, you must take a loan of $20,000 that must be paid back over 5 years. The interest rate is 10%. What will your annual payments be?
- Solution: PV=$20,000, n=5, r=10%

$$20{,}000 = \frac{PMT}{.10}\left[1-\frac{1}{(1+.10)^5}\right]$$
$$\Rightarrow PMT = \$5{,}275.95$$

Example #3: Annuity vs. Perpetuity

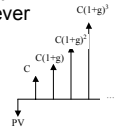
- The PV of a perpetuity approximates the PV of a "long-lived" annuity. To see that this is true, calculate the PV for the following two alternatives, assuming that r = 10%:
  - A. 30-year annuity of $100
  - B. Perpetuity of $100

$$PV_A = \frac{100}{.10}\left[1-\frac{1}{(1+.10)^{30}}\right] = \$942.69$$

$$PV_B = \frac{100}{.10} = \$1000$$

Growing Perpetuity

- Suppose you want to calculate the present value of a growing perpetuity where the cash flow grows at a constant rate forever



- The present value is equal to (note the timing):

$$PV_t = \frac{C_{t+1}}{(r-g)}$$

Example: Growing Perpetuity

- What is the present value of a project that has a cashflow of $100 next year, $105 the following year, $110.25 the following year,…
  (assume r = 8%)
- This is a growing perpetuity with a growth rate equal to 5%

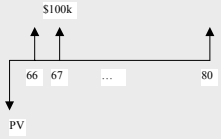
$$PV = \frac{100}{(.08-.05)} = \$3{,}333.33$$

Pop Quiz #1

- Suppose that today is your 30th birthday. You will be able to save for the next 25 years, until age 55. For 10 years thereafter, your income will just cover your expenses. Finally, you expect to retire at age 65 and live until age 80. If you want to guarantee yourself $100,000 per year starting on your 66th birthday, how much should you save each year for the next 25 years, starting at the end of this year. Assume that your investments are expected to yield 12%

Pop Quiz #1: Solution, Step 1

- General Approach: Work backwards



$$PV_{65} = \frac{\$100k}{.12}\left[1 - \frac{1}{(1+.12)^{15}}\right] = \$681{,}086.45$$

Pop Quiz #1: Solution, Step 2

- How much will you need to have saved by age 55 in order to have $681,086.45 by age 65? The answer is the PV of PV_{65} for 10 years.

$$PV_{55} = \frac{681{,}086.45}{(1+.12)^{10}} = \$219{,}291.61$$

Pop Quiz #1: Solution, Step 3

- Finally, how much will you need to save for the next 25 years so that you have $219,291.61 at age 55? The answer is an annuity with a future value of $219,291.61 and a present value of $12,899.46
  (PV = $219,291.61/$(1.12)^{25}$)

$$12{,}899.46 = \frac{PMT}{.12}\left[1 - \frac{1}{(1+.12)^{25}}\right]$$

$$\Rightarrow PMT = \$1{,}644.68$$

Name That Quote

"It is the greatest mathematical discovery of all time."

Who said it?
What was he/she referring to?

Compounding

Compounding Periods

- Often, an annual rate is quoted even though the compounding period is less than 1 year
- Annual Compounding: \$1 invested at an annual rate of 8% compounded annually is worth at the end of one year: $FV = (1+r)PV = (1+.08)\,x\,\$1 = \$1.08$
- Semi-Annual Compounding: \$1 invested at an annual rate of 8% compounded semi-annually (two times per year) is worth at the end of one year:

$$FV = (1+\frac{r}{2})^2 PV = (1+\frac{.08}{2})^2\, x\,\$1 = \$1.0816$$

Compounding Periods

- Monthly Compounding: \$1 invested at an annual rate of 8% compounded monthly yields at the end of one year:

$$FV = (1+\frac{r}{n})^n PV = (1+\frac{.08}{12})^{12}\, x\,\$1 = \$1.0830$$

- Daily Compounding: \$1 invested at an annual rate of 8% compounded daily yields at the end of one year:

$$FV = (1+\frac{r}{n})^n PV = (1+\frac{.08}{365})^{365}\, x\,\$1 = \$1.0833$$

Compounding Periods

- The interest rate r that is compounded is known as the **Annual Percentage Rate (APR)**
- The **Effective Annual Rate** from a given APR will depend on the number of compounding periods

Compounding Periods - Summary

Compounding Intervals per Year	FutureValue of \$1	Effective Annual Rate
1	\$1.0800	8.00%
2	\$1.0816	8.16%
12	\$1.0830	8.30%
365	\$1.0833	8.33%
∞	\$1.0833	8.33%

Example: Mortgage

- Suppose that you decide to buy a \$500,000 house. You make a down-payment of \$100,000 and borrow \$400,000. The mortgage rate is 8% and the payments are made monthly over 30 years. How much is each monthly payment?

$$\$400{,}000 = \frac{\text{PMT}}{(.08/12)}\left[1-\frac{1}{(1+(.08/12))^{360}}\right]$$

$$\Rightarrow \text{PMT} = \$2{,}935.06$$

Example: Mortgage

- Immediately after making your 24th payment (after 2 years), you decide to prepay your mortgage. Find the remaining balance on your loan.

$$PV_{t=2yr} = \frac{\$2935.06}{(.08/12)}\left[1 - \frac{1}{(1+(.08/12))^{(360-24)}}\right]$$

$$\Rightarrow PV_{t=2yr} = \$393{,}040$$

Time Value of Money using EXCEL

- Advantages of EXCEL
  - » Easier to handle variable cashflows
  - » More financial functions (go to "Help", "Index", "Financial Functions" for a list)
  - » Interfaces directly with spreadsheet models
- Primary functions
  - » NPV(rate, value1, value2, …) returns the present value of a stream of cashflows
    - – IMPORTANT NOTE: UNLESS SPECIFIED, EXCEL ASSUMES THAT ALL CASHFLOWS OCCUR AT THE END OF THE PERIOD
  - » PV(rate, nper, pmt, fv) calculates the present value of an annuity (with or without fv)
  - » IRR(values, guess) calculates the discount rate that results in a "zero NPV" for a given stream of cashflows

Mortgage Example using EXCEL

Spreadsheet A

Interest Rate	8.00%	
Month	Payment	NPV
		$36,688
Jan-01	2935.06	
Feb-01	2935.06	
Mar-01	2935.06	
Apr-01	2935.06	
May-01	2935.06	
Aug-30	2935.06	
Sep-30	2935.06	
Oct-30	2935.06	
Nov-30	2935.06	
Dec-30	2935.06	

Spreadsheet B

Month	Payment	IRR
	-400000	0.67%
Jan-01	2935.06	
Feb-01	2935.06	
Mar-01	2935.06	
Apr-01	2935.06	
May-01	2935.06	
Aug-30	2935.06	
Sep-30	2935.06	
Oct-30	2935.06	
Nov-30	2935.06	
Dec-30	2935.06	

We know that the PV should be $400,000.
What is wrong with spreadsheet A?

Investment Evaluation (AKA Capital Budgeting)

Methodologies

- Net Present Value
  - » Criterion: Invest if NPV > 0
- Profitability Index
  - » Criterion: Invest if PI > 1
- Internal Rate of Return
  - » Criterion: Invest if IRR > Opportunity Cost of Capital
- Payback Period
  - » Criterion: Invest if Payback Period<Hurdle Period
- ROE, ROA,…
  - » Criterion: Invest if ratios exceed hurdle

Investment Evaluation – 3 Steps

- Forecast after-tax expected cashflows generated by the project
- Estimate the opportunity cost of capital
- Estimate the value of the forecasted cashflows

Net Present Value

- Net Present Value is the sum of all "adjusted" cashflows
  - » Adjustment reflects time value of money and risk
- Approach
  - » Forecast amount and timing of cashflows
  - » Determine opportunity cost of capital
    - – Should reflect time value of money and risk
  - » Calculate NPV

$$NPV = C_0 + \frac{C_1}{(1+r_1)^1} + \frac{C_2}{(1+r_2)^2} + \frac{C_3}{(1+r_3)^3} + \frac{C_4}{(1+r_4)^4} + \frac{C_5}{(1+r_5)^5}$$

- Example: In New York City, taxi medallions are currently selling for approximately $200,000 and are expected to remain at that price indefinitely. Alternatively, a driver can lease a medallion for $36,400 per year. Assuming that a driver can generate operating after-tax cashflows of $120,000 per year, an opportunity cost of capital of 10%, and a time horizon of 5 years, should a driver buy or lease a medallion?

Example

- In New York City, taxi medallions are currently selling for approximately $200,000 and are expected to remain at that price indefinitely. Alternatively, a driver can lease a medallion for $36,400 per year. Assuming that a driver can generate operating after-tax cashflows of $120,000 per year, an opportunity cost of capital of 10%, and a time horizon of 5 years, should a driver buy or lease a medallion?

NPV: Buy Medallion

Time Period	0	1	2	3	4	5
Activity	Buy Medallion	Operate Cab	Operate Cab	Operate Cab	Operate Cab	Operate Cab
Cashflow	-$200	$120	$120	$120	$120	$120 + $200

$$NPV = -\$200K + \frac{\$120K}{(1+.10)^1} + \frac{\$120K}{(1+.10)^2} + \frac{\$120K}{(1+.10)^3} + \frac{\$120K}{(1+.10)^4} + \frac{\$320K}{(1+.10)^5} = \$379K$$

NPV: Lease Medallion

Time Period	0	1	2	3	4	5
Activity		Lease Medallion	Lease Medallion	Lease Medallion	Lease Medallion	Lease Medallion
Cashflow		$83.6k	$83.6k	$83.6k	$83.6k	$83.6k

$$NPV = \frac{\$83.6K}{(1+.10)^1} + \frac{\$83.6K}{(1+.10)^2} + \frac{\$83.6K}{(1+.10)^3} + \frac{\$83.6K}{(1+.10)^4} + \frac{\$83.6K}{(1+.10)^5} = \$317K$$

•Conclusion: It is better to buy than to lease
(note: operating profits are irrelevant in this example…why?)

Profitability Index

- Recall NPV:

$$NPV = C_0 + \frac{C_1}{(1+r_1)^1} + \frac{C_2}{(1+r_2)^2} + \frac{C_3}{(1+r_3)^3} + \frac{C_4}{(1+r_4)^4} + \frac{C_5}{(1+r_5)^5}$$

- Profitability Index:

$$Profitability\ Index = \frac{\frac{C_1}{(1+r_1)^1} + \frac{C_2}{(1+r_2)^2} + \frac{C_3}{(1+r_3)^3} + \frac{C_4}{(1+r_4)^4} + \frac{C_5}{(1+r_5)^5}}{C_0}$$

- Accept project if discounted value of future cashflows is greater than initial investment

Profitability Index vs. NPV

Time Period	0	1	NPV @ 10%	PI
Project A	-1	11	9	10
Project B	-10	77	60	7.0

- Disadvantage of PI: When choosing between mutually exclusive projects, PI does not adequately address "scale"
  - » Can be fixed by examining marginal investment

66
9

$$Marginal\ Profitability\ Index = \frac{\frac{66}{(1+0.1)^1}}{9} = 6.67$$

- Advantage of PI: Capital Rationing
  - » If there is a limited amount of investment capital, you want to take projects with the highest PV per dollar invested. This is what Profitability Index measures

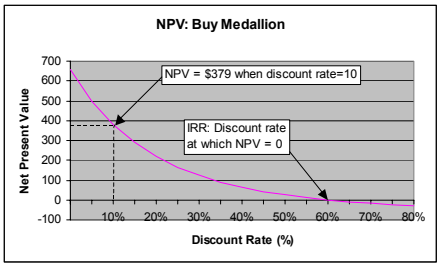
Internal Rate of Return (IRR)

- The Internal Rate of Return (IRR) is the discount rate that makes the NPV of the project equal to zero
- Approach
  - » Calculate amount and timing of cashflows
  - » Calculate the discount rate that makes NPV = 0:

$$NPV = 0 = C_0 + \frac{C_1}{(1+IRR)^1} + \frac{C_2}{(1+IRR)^2} + \frac{C_3}{(1+IRR)^3} + \frac{C_4}{(1+IRR)^4} + \frac{C_5}{(1+IRR)^5}$$

- As the discount rate increases, the PV of future cashflows is lower and the NPV is reduced

IRR (continued)



IRR Example

- Previous Example:
  - » **Buy Medallion:**

$$NPV = 0 = -\$200K + \frac{\$120K}{(1+IRR)^1} + \frac{\$120K}{(1+IRR)^2} + \ldots + \frac{\$320K}{(1+IRR)^5}$$

$$\Rightarrow IRR = 60\%$$

  - » **Lease Medallion:**

$$NPV = 0 = \frac{\$83.6K}{(1+IRR)^1} + \frac{\$83.6K}{(1+IRR)^2} + \ldots + \frac{\$83.6K}{(1+IRR)^5}$$

$$\Rightarrow IRR = \infty$$

  - » **IRR implies that it is better to lease than to buy. Why is the conclusion different from that obtained using NPV?**

NPV vs. IRR

- NPV measures absolute performance whereas IRR measures relative performance
  - » Accept project if NPV > 0
  - » Accept project if IRR > Opportunity Cost of Capital
- IRR has significant shortcomings
  - » Solving for IRR can give multiple solutions. Which one is correct?
  - » IRR is not good at distinguishing between mutually exclusive projects
  - » IRR is not good at accounting for project scale
  - » IRR assumes that interim cashflows can be reinvested at the IRR
  - » IRR does not distinguish between borrowing and lending
  - » IRR is well suited for flat term structure, but not for other term structures of interest rates

Examples of IRR Deficiencies

- Scale

Time Period	0	1	IRR
Project A	-1	5	400%
Project B	-100	120	20%

- Timing of Cashflows: Bias against long-term investments when discount rate is low

Time Period	0	1	2	IRR	NPV @ 0%	NPV@ 10%	NPV@ 20%
Project A	-100	20	120	20%	40	17.3	0.0
Project B	-100	100	31.25	25%	31.25	16.7	5.0

A is a long-term project. As discount rate↑, PV↓
B is short-term project. As discount rate↑, PV↓ less

Payback Period

- Investment Criterion: Accept project if payback period is less than a pre-specified hurdle period
- Suppose the required payback period is 3 years. Would you accept or reject projects A and B?:

Time Period	0	1	2	3	4	5	Accept?
Project A	-100	20	30	50			Accept
Project B	-10	2	2	2	10	1,000	Reject

- Problems with Payback Period
  - » No discounting in the "pre" hurdle period
  - » Infinite discounting in the "post" hurdle period

Other Evaluation Methods

ROA (Return on Assets)
ROI (Return on Investments)
ROFE (Return on Funds Employed)
ROCE (Return on Capital Employed)
ROE (Return on Equity)

$$= \frac{Earnings}{Investment}$$

Problems:
- Denominator (Investment) is a book value, not a market value
- Numerator is earnings, not cashflow
- Ratios typically reflect a single year…they ignore future years

Estimating Free Cashflows

"Cash is King"

- Many unprofitable companies stay in business for a long time…because they have cash
  - » Pharma companies provide good examples:
    - – Alkermes Inc: Sales = $54M, Net Income = -$92.2M, Market Cap = $1.16B, Cash = $104.7M
- Profitable companies go bankrupt…because they run out of cash
  - » Federated Department Stores

Valuation

- Valuing projects and firms requires the calculation of EXPECTED cashflows
  - » "Free Cashflow" = Revenue – Costs – Depreciation – Taxes +Depreciation – ∆NWC – Capital Expenditures
- All of the inputs in the "Free Cashflow" equation can be obtained from financial projections

Forecasting the Future

- Ratios used to assess a firm's health can also be used to forecast future financial performance
- Common approach is to use "Percent of Sales" to forecast income statement and balance sheet items
  - » First, project sales growth
  - » Second, project future ratios (based on past ratios)

Percent of Sales: Example

- Example: $Sales_t$ = $100M, $COGS_t$ = $75M
  - » Assume 5% sales growth
  - » Assume constant COGS/Sales ratio
- COGS Projections:
  - » $Sales_{t+1} = (1 + .05)(Sales_t) = (1.05)(100) = \$105M$
  - » $COGS_{t+1} = (0.75)(Sales_{t+1}) = (0.75)(105) = \$79M$
- Percent of Sales approach is reasonable when
  - » Historic ratios are stable
  - » Significant operational changes are not expected

Other Ratios

- Days Payable, Days Receivable, Inventory Turnover,…can be used to project many balance sheet items
- Examples:

$$A/R_{t+1} = \frac{Days\ Receivable\ x\ Sales}{365}$$

$$A/P_{t+1} = \frac{Days\ Payable\ x\ COGS}{365}$$

- Days Payable, Days Receivable, … can be obtained from:
  - » historical financial statements
  - » industry norms
  - » "bottoms-up" projections

Financial Forecasting

- Bottom Line: Reasonable estimates/ASSUMPTIONS are required for all income statement and balance sheet line items

Free Cashflow Equation

- "Free Cashflow" = Revenue – Costs – Depreciation – Taxes +Depreciation – ΔNWC – Capital Expenditures

Discount Rate

Net Present Value

$$NPV = FCF_0 + \frac{FCF_1}{(1+r)} + \frac{FCF_2}{(1+r)^2} + \frac{FCF_3}{(1+r)^3} + \ldots$$

- NPV requires estimates of **FREE CASHFLOWS** and an estimate of the **DISCOUNT RATE**.
- The discount rate is commonly called the "**COST OF CAPITAL**." What does this mean?
  - » Cost of funds raised?
  - » Opportunity cost of investment?

Cost of Capital

- Cost of Capital = Time Value of Money plus Compensation for Risk
  - = R_f + Risk Premium on Asset I
- R_f is easy to observe…the risk premium is where the challenge lies!
- One of the main topics in finance is understanding the risk premium that investors demand

Return versus Risk

- We assume that individuals don't like risk
- Therefore, in order to bear risk, investors will demand a higher rate of return
- The central tradeoff in finance is between risk and return

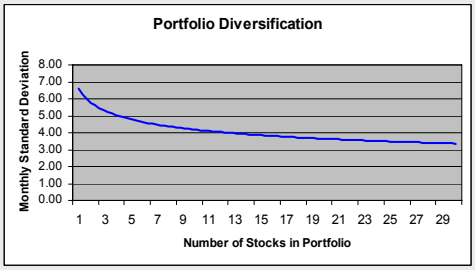
What is Risk?

- What matters is how much risk an asset adds to a portfolio
- The risk that one asset adds to a portfolio depends not only on the asset's variance, but also on the covariance (correlation) of the asset return with the returns on the other assets already in the portfolio

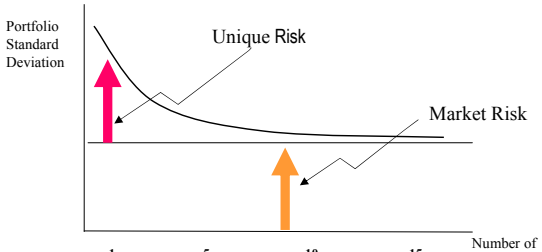
The Benefit of Diversification

- Combining securities into portfolios reduces risk. Diversification works when asset returns are imperfectly correlated
- However, not all risks can be diversified away:
  - » Firm-specific (idiosyncratic) risk can be eliminated through diversification, but market (systematic) risk remains

How Does the Number of Stocks Affect Portfolio Diversification?



Diversification and Type of Risk



Total Risk = Unique Risk + Market Risk
Total Risk = Idiosyncratic Risk + Systematic Risk

Systematic vs. Idiosyncratic Risk

- What kind of risk matters to investors?
  - » Systematic risk matters, idiosyncratic risk can be diversified away
- What is the most diversified portfolio?
  - » The market portfolio is the most diversified portfolio
  - » The risk of the market portfolio is measured by its variance…we cannot diversify further

Systematic vs. Idiosyncratic Risk (continued)

- Therefore, the risk premium on the market portfolio depends on its variance:

  $r_{market} - r_f = f(\sigma_{Market}^2)$
- The risk premium for individual assets depends on how much risk they add to a well-diversified portfolio:

  $r_{asset\ i} - r_f = f(\text{MARGINAL Risk})$

Covariance vs. Variance

- The risk that one asset adds to a portfolio depends primarily on the asset's covariance with other assets in the portfolio
- The effect of variance is small…the effect of covariance is big. Why?

Covariance

- How many covariances enter into the computation of Var(A1 + A2)?
  - » Var(A1+A2) = 2 variances and 2 covariances
- How many covariances enter into the computation of Var(A1+A2+A3)?
  - » Var(A1+A2+A3) = 3 variances and 6 covariances
- How many covariances enter into the computation of Var(A1+A2+…+A100)?
  - » Var(A1+A2+..+A100) = 100 variances and 9900 covariances

Example

- Suppose we invest \$999,000 in a well diversified portfolio, and \$1000 (0.1%) in Yahoo. How much risk does Yahoo add to the total portfolio risk?

$$Var(r_P) = Var(0.999r_{P\text{-}Yaho} + 0.001r_{Yahoo})$$
$$= (0.999)^2 \times Var(r_{P\text{-}Yahoo}) + (0.001)^2 \times Var(r_{Yahoo}) + 2(0.999)(0.001)cov(r_{P\text{-}Yahoo}, r_{Yahoo})$$
$$= (0.998) \times Var(r_{P\text{-}Yahoo}) + (0.000001) \times Var(r_{Yahoo}) + (0.002)cov(r_{P\text{-}Yahoo}, r_{Yahoo})$$

Example (continued)

- What is the marginal contribution of the **VARIANCE** of Yahoo's return to the total portfolio risk?

  $(0.001)^2 = 0.000001 = 0.0001\%$
- What is the marginal contribution of the **COVARIANCE** of Yahoo's return to the total portfolio risk?

  0.002 = 0.2%…2000 times larger!

Covariance vs. Variance

- Consider the effect of further reducing the percentage of Yahoo in the portfolio
  - » The effect of variance diminishes quickly
  - » The effect of covariance diminishes slowly
- Therefore,

  $\Delta Var(r_P)$ is proportional to $Cov(r_{P\text{-}Yahoo}, r_{Yahoo,})$

  Or

  $\Delta Var(r_P)/Var(r_P)$ is proportional to $Cov(r_{P\text{-}Yahoo}, r_{Yahoo,})/ Var(r_P)$
- $Cov(r_{P\text{-}Yahoo}, r_{Yahoo,})/ Var(r_P)$ is known as "Beta" if Portfolio=Market Portfolio
  - » $\beta_{Yahoo} = Cov(r_{Market\text{-}Yahoo}, r_{Yahoo,})/ Var(r_{Market})$

Summary…so far

- Idiosyncratic risk can be eliminated by combining assets in a well-diversified portfolio
- The most diversified portfolio is the market portfolio (includes ALL assets)
- The risk of the market portfolio is measured by its variance…it cannot be diversified further
- For individual assets, return variance is NOT a good measure of risk…the covariance of the asset returns with the returns from a well-diversified portfolio is a much better measure of risk

Capital Asset Pricing Model

- Presumably, investors prefer assets that generate the greatest *excess* return for a given level of risk
- In equilibrium, the ratio of *excess* return to risk should be the same for all investments
- Therefore: $\frac{r_{Market} - r_f}{\sigma^2_{Market}} = \frac{r_{Asset\,i} - r_f}{\sigma_{i,Market}}$
- This simplifies to give an equation for the EXPECTED return for any asset:

$$r_{Asset\,i} = r_f + \beta_{Asset\,i}(r_{Market} - r_f)$$

$$\text{where} \beta_i = \frac{\sigma_{i,Market}}{\sigma^2_{Market}}$$

Discount Rate

- Discount rates account for:
  1. Time value of money
  2. Risk
- Both are accounted for in the Capital Asset Pricing Model (CAPM). CAPM is commonly used to calculate discount rates

$$r_{Asset\,i} = r_f + \beta_i(r_{Market} - r_f)$$

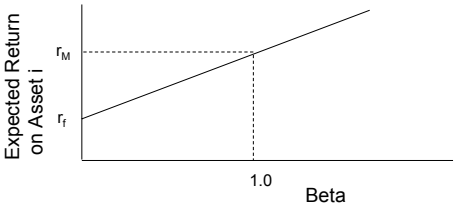
Time value of money — *Risk*

CAPM Derivation

- The formal proof of CAPM requires many assumptions. For example:
  - » Investors have common horizons
  - » Investors have common beliefs about returns and risks
  - » Capital markets are perfect
    - No information asymmetry
    - No transaction costs
    - No differential taxation
- These assumptions can be relaxed to get modified versions of CAPM
- In practice, the simple version of CAPM is used

Security Market Line

$$r_{Asset\,i} = r_f + \beta_i(r_{Market} - r_f)$$



Review Questions

- What is the beta of the market portfolio?
- What is the beta of the risk-free asset?
- What is the expected return of an asset with a negative beta?

Summary

- Portfolio diversification eliminates idiosyncratic risk but not systematic risk
- Because the market portfolio gives the maximum amount of diversification, its risk is measured by variance
- However, for individual assets, only the marginal risk contributed by the asset to the portfolio matters…covariance measures this
- CAPM provides an estimate of an asset's expected return. The key parameter in CAPM is β
  - » A large beta implies that the asset moves with the market. Therefore, it has high risk…investors will require a high expected return to own the asset

Measuring Risk

Measuring Beta

$$\beta_{Asset\,i} = \frac{\text{cov}(r_{Asset\,i}, r_{market})}{\text{var}(r_{market})}$$

- Regression Analysis

$$r_{stock} - r_f = \alpha + \beta(r_{market} - r_f) + \varepsilon$$

Measuring Beta (continued)

- Problem: What if the firm is not publicly traded?
  - » Can't observe r_{stock}
  - » Can't calculate beta
- Solution: Use a "mimicking" firm
  - » Requires one to assume that the mimicking firm's cashflows have the same risk characteristics as the cashflows being analyzed

Measuring Beta (continued)

- For most stocks, EQUITY betas are published
- But you have to adjust published betas for 2 reasons
  - » Asset mix
  - » Financial leverage

Risk

Type	Source
1. ***Systematic*** (correlated with market)	1. ***Business Risk***
2. ***Idiosyncratic*** (firm specific - uncorrelated with market)	2. ***Financial Risk***

Type of Risk

- ***IDIOSYNCRATIC RISK*** can be eliminated by diversifying
  - » Since the cost of diversifying is low (zero), investors do not require compensation for bearing this risk
  - » Stated differently, idiosyncratic risk is not priced

Type of Risk (continued)

- ***SYSTEMATIC RISK*** cannot be diversified away. Therefore,
  - » someone must bear this risk
  - » they will require compensation
  - » Capital Asset Pricing Model (CAPM) can be used to measure the expected return that investors require to bear this risk
  - » β measures systematic risk.

Source of Risk

- Business Risk
  - » Competition, product obsolescence,…
- Financial Risk
  - » Example: Suppose that you want to buy a $200,000 home. Consider two options
    1. Borrow nothing - all equity financed
    2. Borrow $100,000 from the bank at 10% rate, use $100,000 of your own money

Example (continued)

- Suppose house value increases/decreases 20% in one year
  - » Financing Option #1 (All Equity):

$$\text{Gain / Loss} = (.20)(\$200{,}000) = \$40{,}000$$

$$\text{Return}_{-20\%} = \frac{-\$40{,}000}{\$200{,}000} = -20\%$$

$$\text{Return}_{+20\%} = \frac{\$40{,}000}{\$200{,}000} = +20\%$$

Example (continued)

- » Financing Option #2 (50% Debt):

$$\text{Gain / Loss} = (.20)(\$200{,}000) = \$40{,}000$$

$$\text{Return}_{-20\%} = \frac{-\$40{,}000 - \$10{,}000}{\$100{,}000} = -50\%$$

$$\text{Return}_{+20\%} = \frac{\$40{,}000 - \$10{,}000}{\$100{,}000} = +30\%$$

Bottom Line

- Leverage magnifies RETURN and RISK
- β_{Equity} must be adjusted!

Summary

- Observed stock β's are EQUITY betas
- Equity betas reflect both business risk and financial risk
- Since firms and projects may not be financed in the same way, we need to adjust the equity beta for the degree of financial leverage

Levering and Delevering β

Adjusting β for Leverage (continued)

- We need to calculate the ASSET beta
- Alternatively, we need to DELEVER the beta

Leverage Adjustment (continued)

- Key Equation:

  Assets = Liabilities + Equity
- Or, treating Net Working Capital as an asset,

  A = D + E

Leverage Adjustment (continued)

- The return on a portfolio is the weighted average of the individual returns
- Similarly, the beta of a portfolio is the weighted average of the individual betas

Leverage Adjustment (continued)

- Delevering Equation

$$\beta_A = \frac{D}{D+E}\beta_D + \frac{E}{D+E}\beta_E$$

- Levering Equation

$$\beta_E = \beta_A + \frac{D}{E}(\beta_A - \beta_D)$$

Business Risk ***Financial Risk***

Adjusting Rates of Return

- Equations are also valid if rates of return (rather than betas) are used

$$r_A = \frac{D}{D+E} r_D + \frac{E}{D+E} r_E$$

$$r_E = r_A + \frac{D}{E}(r_A - r_D)$$

Portfolio of Assets

$$\beta_A = \frac{\text{Value}_{\text{Asset1}}}{\text{Value of Total Assets}} \beta_{\text{Asset1}} + \frac{\text{Value}_{\text{Asset2}}}{\text{Value of Total Assets}} \beta_{\text{Asset2}}$$

$$\beta_A = \frac{D}{D+E} \beta_D + \frac{E}{D+E} \beta_E$$

Debt Beta's and Expected Rates of Return

- Because debt betas and expected returns are difficult to measure, simplifying assumptions are often used:
  - » Assume a debt beta

Rating	AAA	AA	A	BBB	Junk
Beta	0.19	0.20	0.21	0.22	0.3 - β_{Asset}

Source: Fama, Gene and Ken French, 1993, "Common Risk Factors in the Returns on Bonds and Stocks," *Journal of Financial Economics*, 33, 3-56, Table 4 (Investment grade debt only).

  - » Use promised, not expected, rates of return

Summary

- To value assets, you need to know the risk characteristics of the assets
- "Mimicking firms" are often used to assess a project's risk characteristics
- But you must remember to adjust for:
  1. Asset Mix
  2. Financial Leverage

Quick Review

Basics

- Finance is focused on valuing cashflows that:
  1. Occur at different times
  2. Have different degrees of risk/uncertainty

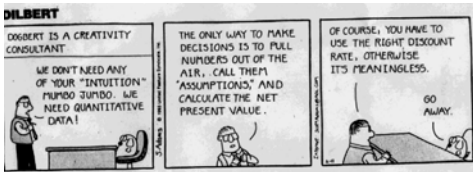
Methodology

- Possibilities include:
  - » IRR, Payback Period, Profitability Index,...
  - » But they have problems!
- Net Present Value

$$NPV = \sum_{t=1}^{T} \frac{\text{Expected Free Cashflow}_t}{(1+r_{\text{Expected}})^t}$$

- FCF = Revenues - Operating Expenses - Depreciation - Taxes + Depreciation - NWC Increase - Capital Expenditures
- $r_{Expected} = r_f + \beta(r_{Market} - r_f)$

Dilbert on Capital Budgeting



Assessing a Corporation's Financial Health

Example: Online Inc.

Income Statement ($millions)	
Revenue	22.2
Cost of Goods Sold	13.9
Gross Profit	8.3
SG&A	3.8
Operating Profit	4.5
Interest Expense	0.4
Taxable Income	4.1
Income Taxes	0.6
Net Income	3.5

Balance Sheet ($millions)			
Assets		Liabilities	
Cash	4.7	A/P	2.1
Inventory	0	Notes Payable	1.5
A/R	5.6	Total Current Liabilities	3.6
Total Current Assets	10.3	Long-term Debt	0.1
PP&E	1.0	Total Liabilities	3.7
Other Assets	0.2	Paid-in Capital	8.9
Total Assets	11.5	Retained Earnings	-1.1
		Total Equity	7.8
		Total L+E	11.5

Four Categories of Health

- Profitability
- Liquidity: short-run solvency
- Leverage: long-run solvency
- Operational

Diagnosing Health: Profitability

- Profitability is typically measured by dividing earnings or cash flow by:
  - » Sales
    - – Gross Margin = (Sales – COGS)/Sales = 8.3/22.2 = 37%
    - – Profit Margin = Net Income/Sales = 3.5/22.2 = 16%
    - – EBIT Margin = EBIT/Sales = 4.5/22.2 = 20%
  - » Total Assets
    - – ROA = Net Income/Total Assets = 3.5/11.5 = 30%
    - – ROIC = (EBIT - Tax)/(Debt + Equity) = (4.5 - 0.6)/9.4 = 41%
  - » Stockholder's Equity
    - – ROE = Net Income/Stockholder's Equity = 3.5/7.8 = 45%

Diagnosing Health: Liquidity

- Ability to meet short-run obligations is typically measured by:
  - » Coverage Ratio = EBIT/Interest Expense = 4.5/0.4 = 11.3
  - » Current Ratio = Current Assets/Current Liabilities
    = 10.3/3.6 = 2.9
  - » Quick Ratio = (Current Assets – Inventory)/Current Liabilities
    = (10.3 - 0)/3.6 = 2.9 (This is also called "Acid Test")
- Liquidity can be improved by:
  - » Reducing short-term financing and increasing long-term financing
  - » Decreasing fixed assets
  - » Increasing working capital level and decreasing working capital requirement

Diagnosing Health: Leverage

- Financial Leverage is typically measured by:
  - » Leverage Ratio = Debt/Total Assets
    = 1.6/11.5 = 14%
  - » D/E Ratio = Debt/Equity
    = 1.6/7.8 = 0.21
- Should BOOK values or MARKET values be used?
  - » In general, market values are most informative
  - » However, rating agencies and lenders often use book values
  - » For capital budgeting and discount rate calculations, always use MARKET VALUES

Diagnosing Health: Operational

- Operating Health is typically measured by:
  - » Asset Turnover = Sales/Total Assets = 22.2/11.5 = 1.93
    - – Note: it may be more informative to use beginning-of-period assets rather than end-of-period assets
  - » Inventory Turnover
    - – Ending Inventory Turnover = COGS/Ending Inventory = ∞
    - – Average Inventory Turnover = COGS/Average Inventory = ? (need last period's balance sheet to calculate this)
  - » Days Receivable = (365 x Accounts Receivable)/Credit Sales
    = (365 x 5.6)/22.2 = 92
  - » Days Payable = (365 x Accounts Payable)/Purchases
    = (365 x 2.1)/13.9 = 55

Overall Health: The DuPont Formula

$$ROE = \frac{Sales}{Assets} \times \frac{Net\ Profit}{Sales} \times \frac{Assets}{Stockholder's\ Equity}$$

Capital Intensity — *Profitability* — *Financial Leverage*

ROE is driven by:
1. Asset Turnover
   (efficiency of generating sales with net assets)
2. Profitability
3. Financial Leverage

Overall Health: Online Inc.

$$ROE = \frac{Sales}{Assets} \times \frac{Net\ Profit}{Sales} \times \frac{Assets}{Stockholder's\ Equity}$$

$$= \frac{22.2}{11.5} \times \frac{3.5}{22.2} \times \frac{11.5}{7.8}$$

$$= 1.93 \times .1577 \times 1.47$$

$$= 0.45 = 45\%$$

Market Measures of Health

- In addition to past performance, market measures reflect future growth opportunities
  - » Earnings per Share (EPS) = Net Income/# shares outstanding
  - » Price to Earnings Ratio (P/E) = Share Price/EPS
  - » Firm Value/EBITDA = (Market Value Debt + Market Value Equity)/EBITDA
  - » Market-to-Book ratio = Share Price/Book Value of Equity per Share

Ratios and Bond Ratings

Three-year (1997-1999) medians	*AAA*	*AA*	*A*	*BBB*	*BB*	*B*	*C*
EBIT int. cov.	**17.5**	**10.8**	**6.8**	**3.9**	**2.3**	**1.0**	**0.2**
EBITDA int. cov.	**21.8**	**14.6**	**9.6**	**6.1**	**3.8**	**2.0**	**1.4**
Free Oper. Cash Flow/Total Debt (%)	**55.4**	**24.6**	**15.6**	**6.6**	**1.9**	**-4.5**	**-14.0**
Total Debt/Total Capital	**26.9**	**35.6**	**40.1**	**47.4**	**61.3**	**74.6**	**89.4**

Source: Standard & Poor's CreditWeek, September 20, 2000, p.41.

One Summary Slide

- Net Present Value

$$NPV = \sum_{t=1}^{T} \frac{\text{Expected Free Cashflow}_t}{(1+r_{\text{Expected}})^t}$$

- FCF = Revenues - Operating Expenses - Depreciation - Taxes + Depreciation - NWC Increase - Capital Expenditures
- $r_{Expected} = r_f + \beta(r_{Market} - r_f)$ where β reflects systematic risk
- Where are the problems/opportunities?

$$ROE = \frac{Sales}{Assets} \; x \; \frac{Net\,\text{Profit}}{Sales} \; x \; \frac{Assets}{Stockholder's\,Equity}$$