Chapter 8
Taxes

MSCI 261
SECTION 1 (CHE/GEOE) AND SECTION 2 (SOFTWARE)

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Overview

- Importance of Taxes
- Impact on MARR
- Canadian Corporate Taxation
  - Capital Cost Allowance
  - Undepreciated Capital Cost
  - Tax Benefit Factor
  - Capital Tax Factor
  - Half-year Rule
- After-tax IRR Analysis

Why we need to consider taxes

- Estimate changes to tax payments, due to an investment
  - Gives estimates of after-tax cash flows
  - Then do PW, AW, or IRR analysis

- Similar to personal tax effects, e.g.:
  - Prof takes extra course, for $7000 extra pay
  - The prof earns $90,000/year without the course
    - But $27,000 is paid in income tax, leaving $63,000 after-tax
  - The prof pays 40% tax rate on extra income
  - Calculate the after-tax pay for the course.

tax paid on $7000 = $7000(.4)=2800
after-tax pay from the course = $7000(1-.4) = $4200

MARR with After-Tax Cash Flows

MARR is minimum acceptable profit, per dollar invested

- profit before-tax > profit after-tax
- therefore, $MARR_{before-tax} > MARR_{after-tax}$
- $MARR_{after-tax} \approx (1-t)* MARR_{before-tax}$, where t = tax rate.

Personal tax example for a Guaranteed Investment Certificate (GIC)

- extra income is taxed at 40%, personal $MARR_{after-tax}$ = 3.5%
- a GIC would pay interest rate (before-tax) = 5%
- Is the GIC good enough ?

① GIC interest after-tax $= 5\%(1-.4) = 3\% < MARR$ after tax

∴ not good

② $MARR_{before\ tax} = \dfrac{MARR_{after-tax}}{1-0.4} = 5.83\% >$ GIC rate before tax

∴ not good

Estimation of Corporate Tax Effects

- Invest P now; new net revenue of R for 10 years
- What is the future tax effect ? – e.g., next year

Income Statement, Next Year (forecast)				Changes
(without investment)		(in millions of $)		
Revenues				
Sales			2010.0	
-Cost of Goods Sold			1304.0	
Net Revenue from Sales			706.0	+ R
Expenses				
Operating Expenses			590.0	
Depreciation Expenses			30.0	+ depreciation on P
Interest Expenses			11.0	
Total Expenses			631.0	
Profit Before Taxes			75.0	+ R – (depreciation on P)
-Income tax @ 30%			30.0	+ 0.3(R – depreciation on P)
Profit After Taxes			45.0	

∴ After-tax cash flow

= R – (extra tax)

= R(1-0.3)+0.3(depreciation on P)

An Important Assumption: “Flow Through”

What if profit in a future year would be negative?

- does company “pay” a negative tax ?
  (meaning, government pays the company)
- NO !!!! The company pays zero tax when before-tax profit < 0 .

This complicates after-tax analysis of investments

- e.g. , government allows depreciation deductions to be delayed to a future, profitable year, reducing taxes in the future.

Assumption for this course:

All future years are profitable. Therefore, all deductions (depreciation, other expenses) are taken in the years that they occur, and not delayed.

Example 8-1: After-tax PW Evaluation

- $105,000 for equipment for new product
- life = 10 years; salvage value = $20,000
- depreciation for tax purposes: $105,000/10 = $10,500/year
  {N.B.: straight-line is NOT NORMAL for Canada ! }
- new product revenue = $25,000 per year for 10 years
- other costs of new product = $6000 per year for 10 years
- $MARR_{after\text{-}tax}$ = 10% ; tax rate t = 30%

rev: \$25000/yr $\rightarrow$ after tax, $25000(1-t)$

costs: \$6000/yr $\rightarrow$ after tax, $6000(1-t)$

P = 105000 $\Rightarrow$ no adjustment at time purchase, but depreciation will lower taxes.

In each year, taxes lowered by $0.3(\underbrace{10,500}_{\text{depreciation expense}})$

Salvage value = \$20000 @ n=10; after tax $20000(1-t)$

$$PW_{after\ tax} = -105000 + 0.3(10500)(P/A,10\%,10) + 20000(1-.3)(P/F,10\%,10) + (25000-6000)(1-.3)(P/A,10\%,10)$$

$$= 1476 > 0$$

$\therefore$ good investment

6000 $\longrightarrow$ reduces NIBT, so reduced income Tax

before-tax cost

6000 - (tax ~~caused~~ less by extra deduction)

$\hookrightarrow 6000(1-.3)$

$\boxed{\text{Naive!}}$

$$MARR_{\text{before tax}} = \frac{10\%}{1-.3} = 14.3\%$$

$$PW_{\text{before-tax}} = -105000 + 20000(P/F, 14.3\%, 10) + (25000-6000)(P/A, 14.3\%, 10)$$

$$= -1788 < 0$$

$\therefore$ not gud

Depreciation in Canadian Corporate Taxation System

- declining balance depreciation is required
  - book value is called "Undepreciated Capital Cost" (UCC)
  - depreciation in a year is called "Capital Cost Allowance" (CCA)
  - declining balance rate d is called "CCA rate"

- CCA rate varies by asset class, e.g.
  - Class 6: frame buildings, d=10%
  - Class 8: machinery, office furniture, …, d=20%
  - Class 30: passenger vehicles, trucks, computers, …, d=30%
  - UCC is tracked by Class: all things in a Class are "pooled"

- Half-Year Rule:
  - depreciable first cost is treated as occurring ½ way through the year, and "prorated" across first two years
  - i.e. ½ of first cost depreciates on first tax return after purchase and other ½ depreciates starting on second tax return after purchase

Tax benefits of 1st \$52500:

First tax return: 52500(.2)(.3)

Second tax return: $\underbrace{52500(1-.2)}_{BV}(.2)(.3)$

Third tax return: $52500(1-.2)^2(.2)(.3)$

⋮

forever

Example 8-2: same as 8-1 but Canadian rules

- \$105,000 for equipment for new product
- life = 10 years; salvage value = \$20,000
- depreciation for tax purposes: CCA rate d = 20%
- new product revenue = \$25,000 per year for 10 years
- other costs of new product = \$6000 per year for 10 years
- $\text{MARR}_{\text{after-tax}}$ = 10% ; tax rate t = 30%

$$PW_{after\text{-}tax}(\text{tax benefits}) = 52500(.2)(.3)(P/F,10\%,1) + 52500(1-.2)(.2)(.3)(P/F,10\%,2) + \cdots$$

infinite series!

First 1/2 of first cost = $\frac{105000}{2}$ = 52500 available for depreciation @ end of 1st year + later

Second 1/2 of first cost = $\frac{105000}{2}$ = 52500 @ end of 2nd year + later

$$CTF = 1 - \frac{td(1+i/2)}{(i+d)(1+i)}$$

$$CSF = 1 - td/(i+d)$$

Present Worth of Tax Benefit on First ½ of First Cost

P = entire first cost, t = tax rate, d = CCA rate, i = $MARR_{after\text{-}tax}$

$$PW(\text{tax benefit}) = \frac{(P/2)td}{(1+i)} + \frac{(P/2)t(1-d)d}{(1+i)^2} + \ldots + \frac{(P/2)t(1-d)^{N-1}d}{(1+i)^N} + \ldots$$

$$PW(\text{tax benefit}) = \frac{(P/2)td}{(1+i)}\left(1 + \frac{(1-d)}{(1+i)} + \frac{(1-d)^2}{(1+i)^2} + \frac{(1-d)^3}{(1+i)^3} + \ldots + \frac{(1-d)^N}{(1+i)^N} + \ldots\right)$$

$$= \frac{(P/2)td}{(1+i)}\left(\frac{1}{1-\frac{(1-d)}{(1+i)}}\right) = \frac{(P/2)td}{i+d}$$

Tax Benefit Factor, TBF = td/(i+d)

Note: "TBF" is an acronym in text's 4th edition but not in the 5th edition.

EX 8-2

$$PW_{after\text{-}tax} = -P * CTF + S * CSF(P/F, 10\%, 10) + (25000-6000)(1-.3)(P/A, 10\%, 10)$$

$$= -105000\left(1 - \frac{(.3)(.2)(1+1/2)}{(.1+.2)(1+.1)}\right) + 20000\left(1 - \frac{(.3)(.2)}{(.1+.2)}\right)(P/F, 10\%, 10)$$

$$+ (25000-6000)(1-.3)(P/A, 10\%, 10)$$

$$= \$2936.89 > 0, \therefore \text{ good investment.}$$

Present Worth of Tax Benefit on Second ½ of First Cost

Second P/2 starts depreciating on second tax return, 1 year later:

PW(tax benefit, 2^{nd} P/2) = (P/2)*TBF*(P/F, i, 1)
= (P/2)*[td/(i+d)]/(1+i)

<u>After-tax First Cost</u>

= P - PW(tax benefit, 1^{st} P/2) - PW(tax benefit, 2^{nd} P/2)
= P*{1 - TBF/2 - (TBF/2)*(P/F, i, 1)}
= P*CTF , where Capital Tax Factor $\mathrm{CTF} = 1 - \dfrac{\mathrm{td}(1+\mathrm{i}/2)}{(\mathrm{i}+\mathrm{d})(1+\mathrm{i})}$

After-tax First Cost and Salvage Values

<u>After-tax First Cost</u>

= P - PW(tax benefit, 1^{st} P/2) - PW(tax benefit, 2^{nd} P/2)

= P*{1 - TBF/2 - (TBF/2)*(P/F, i, 1)}

= P*CTF , where Capital Tax Factor $\mathrm{CTF} = 1 - \dfrac{td(1+i/2)}{(i+d)(1+i)}$

<u>After-tax Salvage Value</u>

- salvage revenue S, at time N, <u>reduces</u> depreciation later
- after-tax value = S – {PW of lost depreciation, at time N}
- rules do not distinguish first half of S from second half

After-tax Salvage = S*CSF, where Capital Salvage Factor

$$\mathrm{CSF} = 1 - \frac{td}{(i+d)} = 1 - \mathrm{TBF}$$

- Note: S*CSF is after-tax salvage <u>at time N</u>; not at time 0.

Back to Example 8-2

- $105,000 for equipment for new product
- life = 10 years; salvage value = $20,000
- depreciation for tax purposes: CCA rate d = 20%
- new product revenue = $25,000 per year for 10 years
- other costs of new product = $6000 per year for 10 years
- $MARR_{after\text{-}tax}$ = 10% ; tax rate t = 30%

Effect of Accelerated Depreciation (faster “writeoff”)

- P.W. of Tax Benefit on first cost P

$$= (P/2)[td/(i+d)] + (P/2)[td/(i+d)]/(1+i)$$

- What happens if government increases d ?
  - e.g. from d = 20% to d = 30%

- $td/(i+d) = t/(i/d + 1)$, so
  - increase d → decrease $i/d + 1$ → increase $t/(i/d + 1)$

- ∴ P.W. of Tax Benefit on first cost P <u>increases</u> when d increases

- e.g., for example 8-2, PW Tax Benefit is
  - for d=20%, $20,045.45
  - for d=30%, $22,551.14

Effect of Accelerated Depreciation

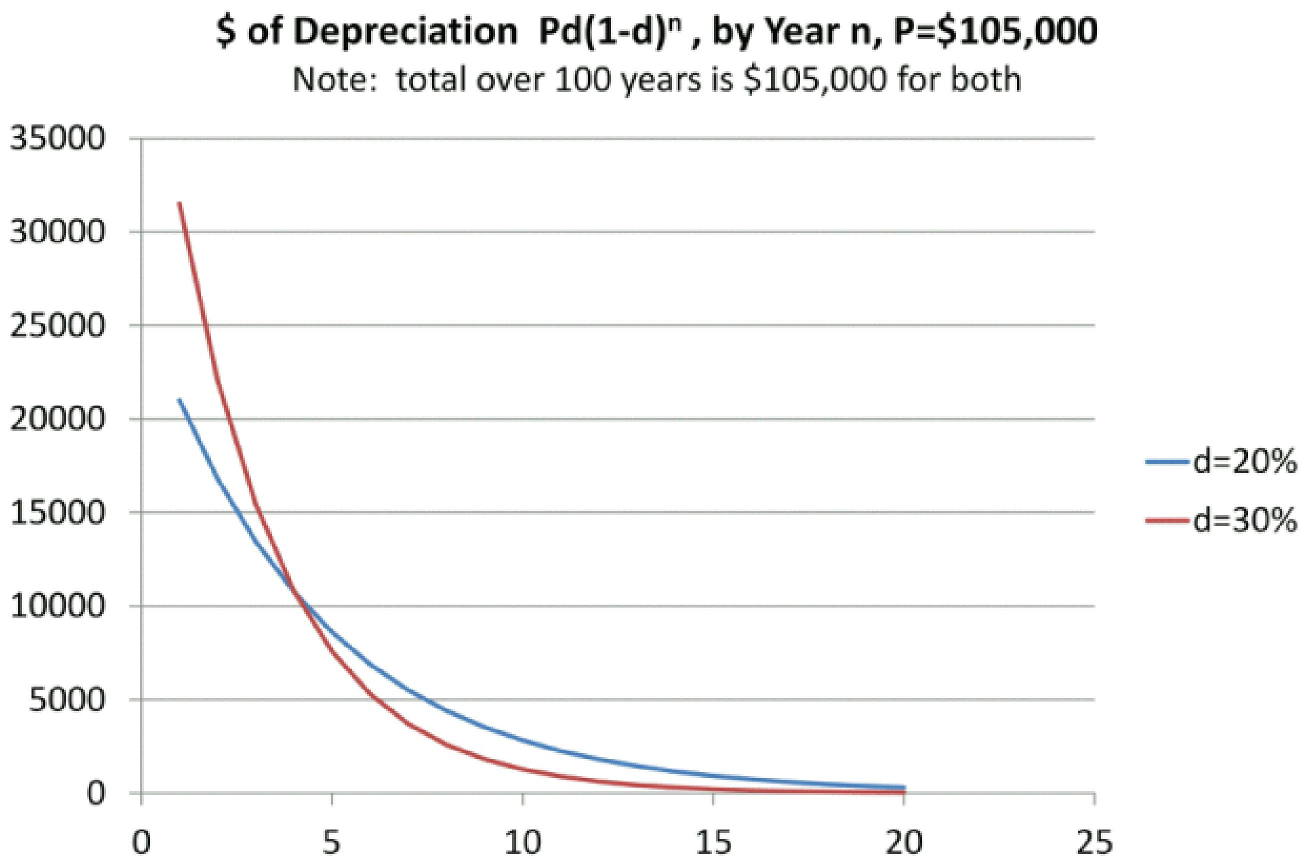
(Intuitive reason why larger d is better for company)

- Total depreciation deduction on first P/2 (same for second)

$$= \sum_{n=1}^{\infty} (P/2)d(1-d)^{n-1} = (P/2)d\sum_{n=1}^{\infty}(1-d)^{n-1}$$

$$= \frac{(P/2)d}{(1-(1-d))} = (P/2)$$

- <u>All of it is depreciated eventually.</u>
- Larger d means benefit is <u>sooner</u>, so more valuable in P.W.
  - think of first year's depreciation, Pd/2


$ of Depreciation Pd(1-d)ⁿ , by Year n, P=$105,000
Note: total over 100 years is $105,000 for both
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
d=20%
d=30%

Example 8-3

A company is about to build a new warehouse costing $400,000. It is not clear, however, whether the Canadian tax laws classify the building as class 3 (CCA rate = 5%) or as class 6 (CCA rate = 10%), since both classes include "buildings".

The company's accountant is going to the tax office to argue that the building should fall under one class or the other. Which class —3 or 6 —do you think the accountant will advocate for the company? Justify your answer.

$$CTF = 1 - \frac{td(1+i/2)}{(i+d)(1+i)} = 1 - \frac{(.25)(.2)(1+.08/2)}{(0.08+.2)(1+.08)} = .828042$$

$$CSF = 1 - \underbrace{\frac{td}{(i+d)}}_{TBF} = 1 - \frac{(.25)(.2)}{(.08+.2)} = 0.821429$$

Example 8-4

An electric pallet truck costs \$12,000. It would save \$4000 per year over its 5 year life and would have a \$2000 salvage value. The after-tax MARR is 8%, the tax rate is 25% and the CCA rate for this type of equipment is 20%. Use the present worth method to evaluate the investment.

$$PW_{after\text{-}tax} = -P*CTF + S*CSF\,(P/F, 8\%, 5) + 4000(1-.25)(P/A, 8\%, 5)$$

$$= -12000(.828042) + 2000(.821429)(P/F, 8\%, 5) + 4000(1-.25)(P/A, 8\%, 5)$$

$$= 3159.72 > 0 \quad \therefore \text{good.}$$

$$AW_{after\text{-}tax} = -P*CTF(A/P, 8\%, 5) + S*CSF(A/F, 8\%, 5)$$
$$+ 4000(1-t) = 791.37/yr.$$

Example 8-5

Redo Example 8-4 using the annual worth method

AW = PW*(A/P, i, n) = $791.37 per year > 0 so good.

“Direct” method for AW: at board.

Find i that solves $PW(i)=0$

$IRR_{after\text{-}tax} = 16.6\%$

$$PW(i) = -12000\left[1 - \frac{(0.25)(0.2)(1+i/2)}{(i+0.2)(1+i)}\right] + 2000\left[1 - \frac{(0.25)(0.2)}{i+0.2}\right](P/F, i, 5) + 4000(1-0.25)(P/A, i, 5) = 0$$

Example 8-6

Redo Example 8-4 using the IRR method

- solve for unknown interest rate
- CTF, CSF depend on *unknown interest rate* (not MARR) !!

Approximate After-Tax IRR Calculation

- To ease the calculation, an <u>approximate after-tax IRR</u> can be estimated from the before-tax IRR as:

$$IRR_{after\text{-}tax} \cong IRR_{before\text{-}tax} \times (1 - t)$$

- Using the numbers from Example 8-6:

  $-12000 + 4000(P/A, i, 5) + 2000(P/F, i, 5) = 0$ for $IRR_{before\text{-}tax}$

  $IRR_{before\text{-}tax} \cong 22.7\%$

  $IRR_{after\text{-}tax} \cong 22.7\%(1 - 0.25) = 17.0\%$ (vs. exact value of 16.6%)

- Compare $IRR_{before\text{-}tax}$ to $MARR_{before\text{-}tax}$
- or $IRR_{after\text{-}tax}$ to $MARR_{after\text{-}tax} = (1- t)^* MARR_{before\text{-}tax}$

- if <u>approximate</u> $IRR_{after\text{-}tax}$ is close to $MARR_{after\text{-}tax}$,

  then <u>exact</u> $IRR_{after\text{-}tax}$ is required

CTF = 0.695906
(d = 30%)
CSF = 0.684211

$$EAC_{after\text{-}tax}(n) = 6300(0.695906)(A/P, 8\%, n) - 6300(1-0.684211)(A/F, 8\%, n) + 1220(1-0.4)(P/A, g=10\%, i=8\%, n)(A/P, 8\%, n)$$

minimum EAC occurs when n = 6.

Example 8-7

A new ATV (all terrain vehicle) costs $6300. It depreciates at 20% per year over its 9 year service life. Operating costs are $1220 for the first year increasing by 10% per year. The CCA rate for ATVs is 30%, the after-tax MARR is 8%, and taxes are at 40%. Compute the economic life of ATV.

[**Note**: management thinks that 20% is more accurate to estimate salvage values; government requires 30% for this broad class of assets]

Read for next class

Chapter 9 from textbook