ECON 2B03 Summary

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# Week 1 − Sustainability

**model**: an simplification of reality that captures information useful and appropriate for a specific purpose

**linear product lifecycle**: energy in and out at every stage



**closed-loop product lifecycle**: recycling, re-use, energy only lost at consumer level



**Ingenuity Gap**: the gap between requirements and solutions, which is caused by an increasing complexity (?)

## Triple-Bottom Line

Focuses on:

* **Social sustainability**: productive service to society
* **Environmental sustainability**: resources/land
* **Economic sustainability**: cost efficient

## Seven Revolutions

1. Markets: compliance to competition
2. Values: hard to soft
3. Transparency: closed to open
4. Life-cycle Technology: product to function
   1. Companies responsible for entire product life-cycle
5. Partnership: subversion to symbiosis
   1. Companies cooperate
6. Time: wider to longer

# Week 2

**Cash-flow period**: time over which you are calculating effective interest rate

**Interest** [*I*]: compensation for giving up the money

**Nominal**: doesn’t account for inflation

**Annual interest rate** [*r*]: nominal interest rate over one year

**Present worth** [*P*]:

* The amount of money that is currently being dealt with (whether being loaned, or an annuity)
* Before initiating a time period exchange, the present worth is known as the **principle amount**
* Trying to bring all arrows on cash flow diagram to 0 (one period before the first payment)

**Future Worth** [*F*]: the future value of the time period exchange

**Interest period** [*m*]: interest compounds per year (not cashflow periods)

**Cash flow period (cfp)**:or *payment period* is how long it is between your payments

Don’t forget that there are 4 quarters in a year and 3 months in a quarter-year.

**Nominal Interest rate per cfp** [*i*]: interest for each interest period

**Number of compounds per cfp** [*k*]: should never be a fraction

My way of calculating it is:

**Effective Interest rate** [ie]: overall interest rate that takes compounding and payment periods into consideration



**Effective interest per cash flow** [ie/k]: 

Your effective interest rate should be close to nominal interest rate/cash-flow periods per year.

## Methods of Interest Calculation

* [Lump Sum](#_Lump_Sum)
* [Simple Interest](#_Simple_Interest)
* [Compound interest](#_Compound_Interest)

### Lump Sum

**Lump sum**: one payment at the end of the time period exchange covers all the funds borrowed, so there is only one interest calculation. The interest on a lump sum does not change over time, but simply the amount paid.





### Simple Interest

**Simple interest**: a method of calculating interest that is based off the time it takes to pay off the loan and the principle amount



### Compound Interest

**Compound interest**: a method of calculating interest that charges interest on the principle as well as unpaid interest each “compound”



With compound interest comes a **compound period**, which is the amount of time, until interest begins to be charged on unpaid charges on top of previous unpaid interest. Compounding periods are assumed to have equal length.



### Continuous Compound



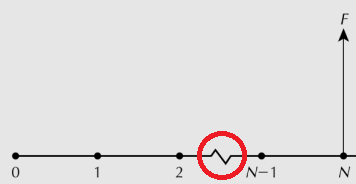
## Cash Flow Diagrams

Cash flow diagrams are graphical representations of a system that aid in analysis of cash flows

Since each cash flow is paid as an impulse, instead of continuous outflow from an account, the cash flows are represented by arrows, which can be positive (up) or negative (down) on a chart where time is along the y-axis (represented horizontally) and the cash flow is represented along the x-axis (represented vertically)



Sometimes when there are repeated points, with the same value, we represent the area with repeated points with a *squiggle* on the cash flow diagram:



**Linear Interpolation**: using 2 different *i*’s: one that’s bigger than the desired one and one that’s smaller than the desired one



Sometimes you can approximate to i = r/m

actually, your x’s are i’s in this case (change that)

y’s are your annuities

y2 would be your given A at given N and a guessed (upper bound) x2 and y1 would be the A at the point in the table at your given N and x1.



# Week 3

## Equivalence

**Equivalence**: when the value of something is the same at the one period as at a different period, which is determined by the interest rate

* **Mathematical**: comparing future to present by a factor of *time*
* **Decisional**: comparing future to present by a factor of *periods*
* **Market**: (?)

Note: a payment at time 0 can be assumed to occur at the end of the previous period

## Compound Interest Factors

A/B: A given B; A is unknown, B is known

**Number of payments** [*N*]: total periods − first payment + 1[interest begins from day one, payment does not];

Number of arrows on cash-flow diagram

### Compound Amount Factor





### Present Worth Factor



### Sinking Fund Factor



### Uniform Series Factor



### Capital Recovery Factor





**Salvage value** [*S*]: value after process is complete (usually 0)

### Series Present Worth Factor



# Week 4

## Growth-Adjusted Interest Factors

### Arithmetic Gradient Series Factor

**Base payment of Annuity** [*A'*]

**Nominal increase of an annuity** [*G*]: also known as gradient



A': base annuity cost





|  |  |
| --- | --- |
| **Cases** | **Meaning** |
| A > 0, G > 0 | Positive annuity, increasing cash flow |
| A > 0, G < 0 | Positive annuity, decreasing cash flow |
| A < 0, G > 0 | Negative cash flow, decreasing magnitude |
| A < 0, G < 0 | Negative cash flow, increasing magnitude |

Remember that the first compounding period has G = 0

## Arithmetic Gradient Series Factor

**Percentage Increase of an Annuity** [*g*]

**Growth-adjusted interest rate** [i°]: 





|  |  |  |
| --- | --- | --- |
| **Cases** | **Meaning** | **Procedure** |
| i > g > 0 | Positive *growth*, but  decreasing *interest rate*, so  *i0* is positive | Use tables or formulas |
| g > i > 0 | Positive *growth*, but  increasing *interest rate*, so  *i0* is negative | Use formulas only |
| g = i > 0 | *Growth* = interest rate, so  *i0* is zero |  |
| g < 0 | Negative *growth*, so  *i0* is positive | Use tables & formulas |

**Discrete Model**: cash flows occur at the end of periods

**Continuous Model**: compound continuously over time

Long-lived projects:

**Amortization**: number of years it would take to repay a mortgage loan in full for a given interest rate and payment schedule

**Term**:

**Mortgage**:

P = Total – Down



The default for car loans and mortgages is to convert the interest rate into monthly compounding from annual.

How much of a given payment, M, within an annuity is interest: (value of annuity) – (FN−1 – FN)

# Week 5

## Bond

**Bond**: issuer of a bond takes a loan from the investor

* **purchase price**: amount “lent”
* **going interest rate**: interest rate of
* **par**/**face value**: total nominal amount the issuer will have given back to the investor
  + the difference between this and purchase price depends on the going interest rate (≠ coupon rate)
* **coupon rate**: the annual percentage of the par value that the issuer pays the investor, similar to monthly mortgage payments
  + The default frequency for payments is semi-annually (i.e. every 6 months), so i = r/2
* **maturity date**: set end date of loan
* a type of fixed-income security, since you know how much you’ll get back
* useful if fluctuating stock market

The coupon rate is stated for the year, but you need to cut that by how many times (multiply by face value/times received) you get the coupon, just as you need to cut down your nominal interest by number of compounds for any other interest

## Comparison Methods

* **PW Method**: examine present worth of all project cash flows
* **AW method**: convert all cash flows to annuities

**Payback Period**: number of years it takes for an investment to be recouped = 

**Assumptions**:

1. Costs & benefits are always measurable by money
2. Future cash flows are known with certainty
3. Cash flows are unaffected by inflation/deflation
4. Sufficient funds are available
5. Taxes are not applicable
6. Down payments ≤ proceeding cash flows

**Fixed rate**: fixed as a percentage of par value

**Floating rate**: adjustable interest payments

## Characteristics of Projects

### Independent

benefits of choosing one project doesn’t affect the other project, so it is possible to choose multiple projects

### Mutually Exclusive

Choosing one makes it impossible to pick the others

### Related but not mutually exclusive

Choosing one project will affect the benefit of another, but it is possible to do both

For example, building 1 train station vs 2 means that the benefit of project 1 will be decreased by that of the benefit of project 2, since some of the number of people who would go to station 1 would go to station 2, instead. This doesn’t mean the railway company won’t have additional increase from building the 2nd station

## MARR

**Minimum Acceptable Rate of Return** (MARR): an interest rate that must be earned for a project for it to be worthwhile

* would have to be larger for tech companies, since they can’t afford to stretch projects over longer periods of time
* if it is < 0, you are losing money

Investing: greatest present worth (PW)

Minimum cost problems: least PW

If you need to compare to figure out which is the best option, doing an annual worth will save time because you only have to calculate for one year.

1. Imagine cash flow diagram as annuities
2. Alternative with largest annuity is the best

### Unequal Lives

When you have projects with different time periods, you need to consider the methods of comparing the projects.

* Repeated Lives: Lowest Common Multiple of the service lives
* Adopted Study period: specific time period (some may not be active for part of the time, but overall they’re [hopefully] better), usually if projects cannot be repeated

# Week 8 − IRR

**IRR** [i\*]: Internal Rate of Return−doesn’t include external factors, like interest or inflation

* interest rate when Net Present Value (NPV) = 0
* Pin = Pout­
* e.g. If $100 is invested today and it returns $110 in a year, IRR = 10%

## NPV

**NPV**: Net Present Value (a.k.a. normal IRR question)

* Bring all cash flows to the present and add them together
* Include the signs for each of the cash flows
* Useful when comparing multiple [independent](#_Independent) projects
* Note: when not given an IRR, guess *i*\* = MARR

Here’s the idea:



**Receipts** [R]: outflows

**Disbursements** [D]: inflows

### Steps

1. Put everything in the present, using i = i\* = MARR
2. Choose the highest one.
3. If there are multiple highest, choose the one with the largest nominal gain.

## Incremental Analysis

**Incremental Rate of Return** [ΔIRR]: calculating the optimal project when the projects are [mutually exclusive](#_Mutually_Exclusive)

ΔIRR = Challenger – Defender

PW = Pc − Pd

e.g. 1) ΔA(P/A, MARR, N) – ΔP

e.g. 2) Ac(P/A, MARR, N) – Gd(A/G,MARR,N)(P/A,MARR,N) – (Pc – (Pd – Ginit))

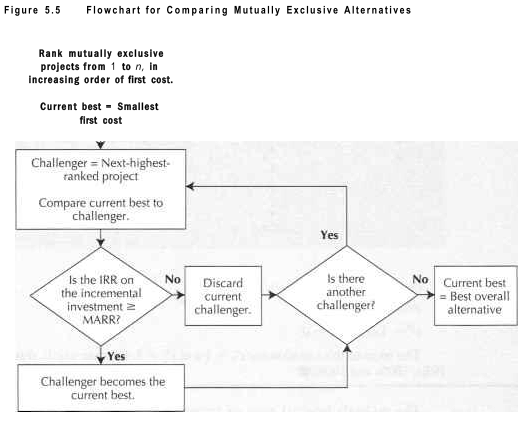
PW ≥ 0 => IRR ≥ MARR => choose challenger

PW < 0 => IRR < MARR => choose defender

Note: reverse when borrowing

Identify all options, including doing nothing (not picking any options)

Follow this flow chart:



Sometimes you’re given an amount to invest. In that case, when calculating each ΔIRR:

* You are finding a weighted average
* The amount of the investment that is unused uses the MARR as an i
* The amount that is used uses



## ERR

**ERR** (External Rate of Return) [ierr\*]: the rate of return on a project where all cash flows that are not invested in the project are assumed to earn interest at a predetermined rate (such as the ΔIRR). Use this when you have multiple sign changes

today (F/P, MARR, N) − annuity rate + later (P/F, ierr\*, N) = 0

**Approximate ERR** [iea\*]: since ERR is too difficult, just use this to find an approximation

net receipts at MARR = net disbursements at iea\*, find iea\*

It’s a good investment if iea\* > MARR

# Week 9

If you see illegal activity, document and report to superiors. If it poses a serious threat and they don’t do anything then it’s your call if you whistleblow. Either way, document everything.

# Week 10

**Depreciation** [D]: the loss in value of a capital asset, since most things lose value as soon as it’s purchased

D(*n*) is the amount of depreciation in the nth period

Some things **appreciate**, but most things don’t.

* art
* old alcohol

Some follow an arc, where they depreciate, then appreciate

**Market Value** [MV(*n*)]: value an asset can be sold for in an open market

**Purchase Value** [*p*]: the amount paid at purchase

MV(purchase) = MV(0)

**Book Value** [BV(*n*)]: value of asset, with depreciation accounted for

Let *N* = useful life of assets in periods

Note: this represents the usefulness to the given project, not in general, i.e. the asset can still have a salvage value after *N* periods

**Scrap Value**: value of asset when sold at end of physical life (broken for parts, etc.)

Let [S] = Scrap Value and/or Salvage Value

S = BV(*N*)

Types of depreciation:

* [Straight-line](#_Straight-Line): BV decreases equal amount
* [Declining balance](#_Declining_Balance): BV decreases equal proportion (i.e. percentage)

## Straight-Line

Idea: BV decreases an equal amount

*D*total = *D*(*N*) = *p* – *S*



BV(n) = p – n × D(n)

## Declining Balance

Idea: BV decreases by a percentage

**Depreciation rate** [d]



BV(*n*) = *p* × (1 – *d*)*n*

## Replacement Decisions

Mutually exclusive options of determining what to do with existing/unnecessary/obsolete:

* Do nothing
* Upgrade/repair
* Get rid of it
* Get rid of it and replace it

Should you replace existing, unnecessary, obsolete, and/or damaged assets (machinery, software, etc.)?

**Defender**: existing asset

**Challenger**: replacement

Reasons:

* Reduced performance: extensive usage causes physical deterioration, reducing reliability and productivity
* New requirements
* Obsolescence and/or lack of support/spare parts
* Installation costs are not depreciable
* When installed, defender has cost advantage
* Sunk costs are irrelevant
  + i.e. even if you just spent a shit ton on repairing your car, you don’t include that in your decision of whether to sell or not

O & M: Operating & Maintainance

**Equivalent Annual Costs (EAC)**: annual costs of replacing the machine every N years

EACtotal = EACcapital + EACOP&M

EACcapital = [capital recovery factor](#_Capital_Recovery_Factor) =

**One-year principle**: if the cost of keeping the defender one more year exceeds the EAC of the challenger at its economic life, then the defender should be replaced immediately

Replace if:

* Defender = Challenger
* Defender ≠ Challenger0 ≠ Challenger1 = Challenger2…N
* Defender ≠ Challengers (each challenger is unique)

# Week 11 − Taxes

**Capital**: Revenue − Expenses

**Undepreciated Capital Cost (UCC)**: remaining capital balance

UCC = Capital – CCAprevious

**Capital Cost Allowance (CCA)**: maximum level of capital cost expense (depreciation) which a company can claim each year

CCA = UCC × CCA Rate

**Half-year rule**: only one-half of the value of the depreciable asset bought in the current year can be used for current year CCA

i.e. CCAbase = UCCbase/2 × CCA Rate

**Tax Rate** [*t*]:

Tax Amount = Tax Revenue – Tax Savings

= ((Revenue – Operating Expense) × t) – ((CCA) × t)

= (Revenue – Operating Expenses – CCA) × t

**Scientific Research and Experimental Development (SR&ED)**: a program that provides a tax rebate on the average of the last three years of eligible R&D expenditures, 20% to a large corporation, but more to smaller corporations

**Capital Salvage Factor (CSF)**:

**Capital Tax Factor (CTF)**:

{finding present worth, etc., but you multiply first cost by CTF, savings/expenses by (1− *t*), and salvage value by CSF

the savings/expenses are annual

whatever is annual is multiplied by (1− *t*), first costs with CTF and salvage value by CSF}fixxx

# Week 13

**Real interest** [*i'*]: interest accounting for inflation



**Inflation rate** [*f*]

**Differential Inflation**: some items inflate at different rates than the majority of the economy

**Real Cash Flow** [*R*]: cash flow accounting for inflation



C = current cash flow

N = # of years