VOLUME 01

ENGINEERING ECONOMY

TAXATION

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PREFACE

This eBook is intended to provide Malaysian Polytechnics' students with a clear yet simple explanations of taxation within the context of engineering economics, offering a comprehensive exploration of concepts, principles, and real-world applications.

Taxation, a fundamental aspect of any economy, has a profound impact on engineering projects, investment decisions, and overall economic sustainability. This eBook aims to demystify the complexities of taxation and equip engineering professionals, students, and enthusiasts with the knowledge necessary to navigate the intricate web of fiscal policies, tax codes, and financial strategies.

It is hoped that the book will be useful and tremendous help for the students in the basic of taxation in engineering economic.

ACKNOWLEDGEMENT

With sincere gratitude, we acknowledge the multitude of individuals who have contributed to the creation of this student-centric eBook on Engineering Economics: Taxation. Our appreciation extends to the dedicated educators who inspire learning, the fellow students who foster shared understanding, the supportive families who enable our pursuits, and the experts whose insights enrich our work. This collaborative effort has shaped a comprehensive resource that we hope will empower students to navigate the intricate realm of Engineering Economics and Taxation with confidence and insight.

With gratitude,

Samikhah Muhammad@Munir
Dr Azuin Ramli
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2023

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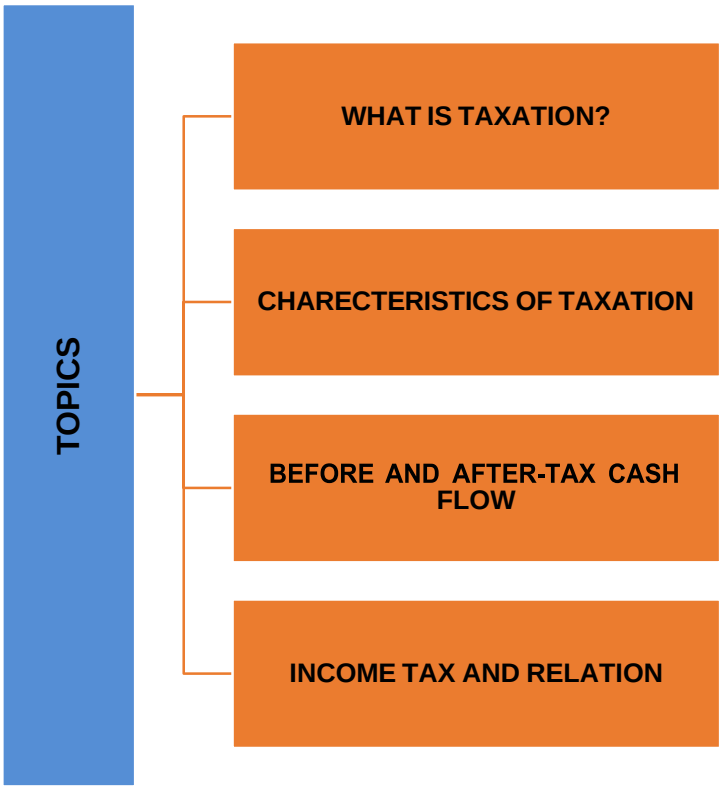
TAXATION

LEARNING OUTCOMES

- Define engineering economics consequence of decision making based on principle concept and analysis method in economics.
- Define benefit and costing associated to the civil engineering project accordingly to the project given.



1.0 WHAT IS TAXATION?

Tax is defined as a compulsory contribution levied on persons, property, or businesses for the support of government for economic and social operations. In other words, it is money paid to a government to fund its programs and services.

What happens if there is no tax?

If no one filed their income tax, that would mean a huge increase in tax evasion, and much less money for the federal government, which already runs substantial deficits, and a country will become unmanaged.

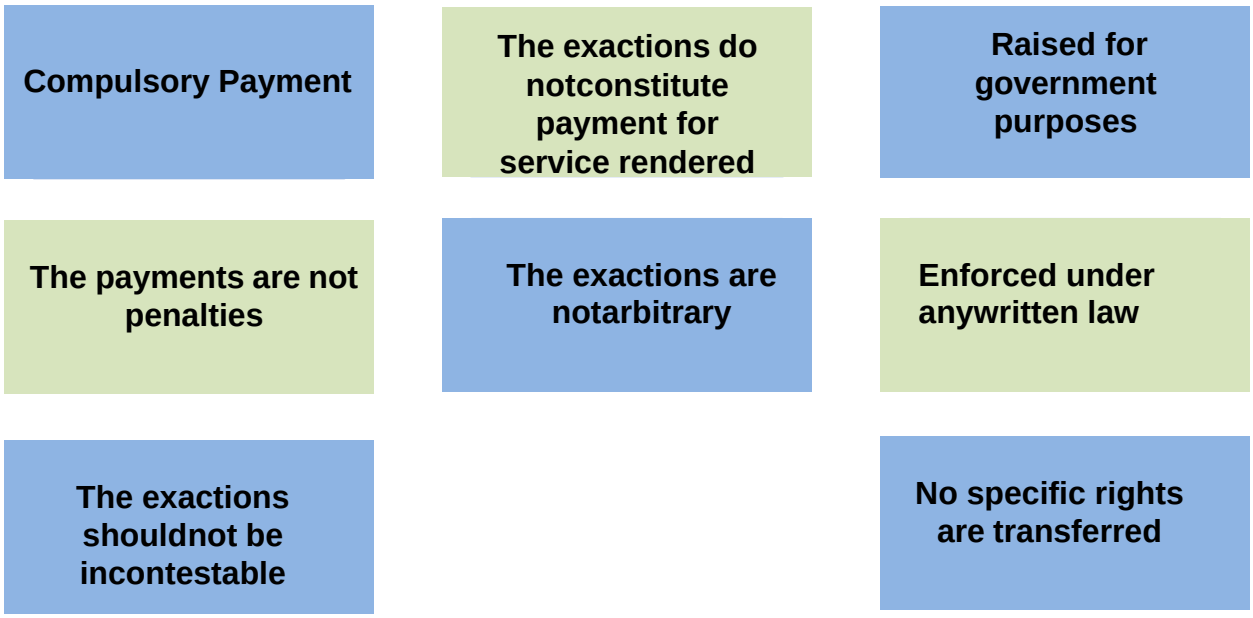
Why do we need taxes?

Without a tax system, a government would not have any money to provide services. Governments need to fund the services they provide to the community, such as education, health, defense, and infrastructure such as roads. Citizens support the tax system by paying their fair share of taxes. In turn, they receive services and benefits fromtheir government.

Main Objectives of Taxation

a) To fund government development and social expenditure.
b) To be collected efficiently and at minimum cost to government and to taxpayers.
c) Taxes can be used as a fiscal tool to maintain the desired level of employment and increase economic development and growth.
d) Taxes are used as policy measures to encourage activities beneficial to the country and to discourage those which are not (for example smoking and consuming alcohol)

Characteristics of Taxation



2.0 PRINCIPAL OF TAXATION

Basic concepts by which a government is meant to be guided in designingand implementing equitable taxation regime. These include:

e) **Adequacy:** taxes should be just enough to generate revenue requiredfor provision of essential public services.
f) **Broad Basing:** taxes should be spread over as wide as possiblesection of the population, or sectors of economy, to minimize the individual tax burden.
g) **Compatibility:** taxes should be coordinated to ensure tax neutrality andoverall objectives of good governance.
h) **Convenience:** taxes should be enforced in a manner that facilitates voluntary compliance to the maximum extent possible.
i) **Efficiency:** tax collection efforts should not cost an inordinately high percentage of tax revenues.
j) **Equity:** taxes should equally burden all individuals or entities in similar economic circumstances.
k) **Earmarking:** tax revenue from a specific source should be dedicated to a specific purpose only when there is a direct cost and-benefit linkbetween the tax source and the expenditure, such as use of motor fuel tax for road maintenance.

l) **Neutrality:** taxes should not favour any one group or sector over another and should not be designed to interfere with or influence individual decision-making.

m) **Predictability:** collection of taxes should reinforce their inevitability and regularity.

n) **Restricted exemptions:** tax exemptions must only be for specificpurposes (such as to encourage investment) and for a limited period.

o) **Simplicity:** tax assessment and determination should be easy tounderstand for an average taxpayer.

Factors that define a Tax System

There are various characteristics that define a tax system, such as:

a) Who pays the tax
b) The base to be taxed
c) The rates of tax to be applied to the base
d) General exemptions
e) General deductions
f) Other selective measures such as how to pay tax

Effects of Taxation

a) **Personal Income Tax** which is presumed to fall entirely on the legal taxpayers influences decisions to work, save, and invest. These decisions affect other people.

b) **Corporate Income Tax** may simply result in lower corporate profits and dividends. It may reduce the income of all owners of property and businesses. The company may move toward raising the prices of their product.

3.0 BASIC CONCEPT OF TAXATION

a) Direct Tax

Taxes levied on a person's income and wealth and is paid directly to the government. It paid directly by those on whom it is levied.

Example of direct taxes:

Income tax (Including corporate tax), Petroleum income tax, Stamp duty and Real property gains tax.

b) Indirect Tax

Taxes levied on person's who consumes the goods and services and is paid indirectly to the government. It is a fee that is levied equally upon taxpayers, no matter how much their income. It is collected via third party.

Example of indirect taxes:

Government service tax (GST), sales tax, value added tax (VAT), excise duty, customs duties, and service tax.

Direct Taxes	Indirect Taxes
Income tax (Including corporate tax)	Customs duties
Petroleum income tax	Excise duty
Stamp Duty	Service tax
Real Property gain tax	Sales tax

4.0 MALAYSIAN INCOME TAX RATE

i. Resident individual taxpayers

Graduated scale of rates from 0% (on the first RM2,500) to a maximum of 26% (forincome exceeding RM100,000)

Resident Individuals:

Table 4.1: Example of Resident Individual Taxpayers (Source: http://phl.hasil.gov.my/pdf/pdfam/appendix_2013.pdf)

Resident individuals are subject to income tax at progressive rates as follows (Year of Assessment 2010):	
Chargeable Income (Malaysian Ringgit)	**Marginal Tax Rate (%)**
Up to 2,500	0
2,501-5,000	1
5,001-20,000	3
20,001-35,000	7
35,001-50,000	12
50,001-70,000	19
70,001-10,0000	24
Exceeding 100,000	26
Preferential tax rate of 15% is given to knowledge workers in Iskandar Malaysia.	

ii. Non-resident individual taxpayer

Flat rate of 26% with no personal reliefs.

iii. Companies

a) Paid-up capital ≤ RM2.5 million

20% on the 1st RM500,000 chargeable income

25% on the subsequent chargeable income exceeding RM500,000

b) Paid-up capital > RM2.5m

Fixed rate of 25%

Self-Assessment System

The Malaysian tax system is based on self-assessment. Self-assessment is considered the most economical and efficient way to collect income tax. Self-assessment system (SAS) was implemented on companies from the year of assessment 2001 and on individuals and other taxpayers from 2004. Under the SAS, taxpayers determine their taxable income, compute tax liability, and submit tax returns. Company under SAS will:

a) Provide estimate of the tax payable one month prior to the commencement of the business
b) Estimates shall not be less than 85% of the previous year's estimate.
c) May revise estimates in the sixth and ninth month of the relevant basis period.
d) File tax return within seven months of the close of the financial year end.

Company Taxation

A 'Company Tax' is defined under the Income Tax Act, 1967 as a body corporate and includes anybody of persons established with a separate legal identity by or under the laws of a territory outside Malaysia. The rate of Corporation Taxation in Malaysia is in average of 24.0 % from the year of 1997 until 2015 (Figure 4.1). Corporate Tax Rate in Malaysia is reported by the Inland Revenue Board of Malaysia. The amount of tax is based on the net income companies obtain during one business year.

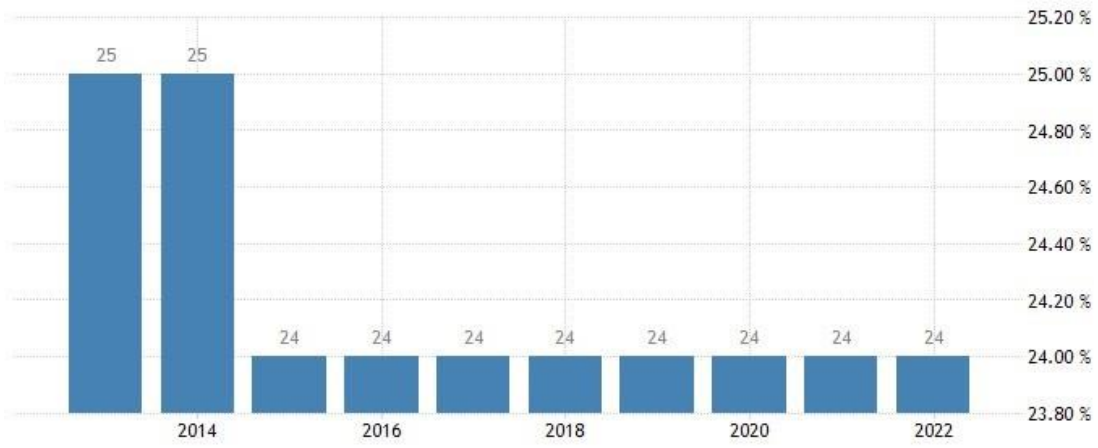


Figure 4.1: The Corporate Tax Rate in (Source: Inland Revenue Board of Malaysia)

5.0 BEFORE AND AFTER-TAX CASH FLOW

Before Tax Cash Flow	Cash Flow after Tax
• The cash flow a person or company realizes after subtracting debt service and other expenses but nottax liability. • Before-tax cash flow represents cash available to pay off creditors inthe event of liquidation. While it is an important measure, it is not as closely watched as earnings beforeinterest and taxes.	• Cash flow after taxes is a measure of financial performance that looks at the company's ability to generate cash flow through its operations. It is calculated by adding back non-cash accounts such as amortization, depreciation, restructuring cost and impairments to net income. • Cash Flow After Tax = Net Income + Depreciation + Amortization + Other Non-Cash Charges

Cash Flow after Tax (CFAT)

NCF is cash inflows – cash outflows. Now, consider taxes and deductions, such as depreciation.

Cash Flow Before Taxes (CFBT)

CFBT = Gross income (GI) – Expenses (OE) – Initial Investment (P) + Salvage (S or F

Cash Flow After Taxes (CFAT)

CFAT = CFBT – Taxes = GI – OE – P + S – (GI – OE –D) (Te)

Example 1

Wilson Security plans to purchase listening and detection equipment for use in the 6-year contract. RM 550,000 Equipment cost, Resale value of RM150,000 after 6 years, Revenue increase by RM 200,000 per year, Additional M&O of RM 90,000 per year, Depreciation allows recovery in 5 years, Effective corporate tax rate of 35% per year. Computation of CFBT and CFAT USING MACRS depreciation and T_e = 35%

Solution:

Year	Revenue R	Operating expenses, OE	Basic B & Salvage S	CFBT	Depreciation D	Taxable income, TI	Taxes	CFAT
0			-550,000	-550,000		0	0	-550,000
1	200,000	-90,000		110,000	110,000	0	0	110,000
2	200,000	-90,000		110,000	176,000	-66,000	-23,100	133,100
3	200,000	-90,000		110,000	105,600	4,400	1,540	108,460
4	200,000	-90,000		110,000	63,360	46,640	16,324	93,676
5	200,000	-90,000		110,000	63,360	46,640	16,324	93,676
6	200,000	-90,000	150,000	260,000	31,680	78,320	27,412	232,588
Totals					550,000			

After-Tax Evaluation

a) Use CFAT values to calculate PW, AW, FW, ROR, B/C, or other measure of worth using after-tax MARR.

b) Same guidelines as before-tax; e.g., using PW at after-tax MARR:
   i. One project: PW ≥ 0, project is viable.
   ii. Two or more alternatives: select one ME alternative with best (numerically largest) PW value.

c) For costs only CFAT values, use + sign for OE, D, and other savings and use same guidelines.

d) Remember: equal-service requirement for PW-based analysis

e) ROR analysis is same as before taxes, except use CFAT values:
   i. One project: if i* ≥ after-tax MARR, project is viable.
   ii. Two alternatives: select ME alternative with Δi^* ≥ after-tax MARR for incremental CFAT series.

Approximating After-Tax ROR Value

To adjust a before-tax ROR without details of after-tax analysis, an approximating relation is:

After-tax ROR ≈ before-tax ROR × (1 – Te)

Example 2:

P = $-50,000 GI – OE = $20,000/year

n = 5 years D = $10,000/year Te = 0.40

Estimate after-tax ROR from before-tax ROR analysis.

Solution: Set up before-tax PW

relation and solve for i*0 = - 50,000 +

20,000 (P/A, i*%,5)

i* = 28.65%

After-tax ROR ≈ 28.65% × (1 – 0.40) = 17.19%

(Note: Actual after-tax analysis results in i* = 18.03%)

Example 3: After-Tax Analysis

Asset: B = $90,000, S = 0, n = 5 years

Per year: R = $65,000 OE = $18,500 D = $18,000

Effective tax rate: T_e = 0.184

Find ROR a) before-taxes, b) after-taxes actual and c) approximation.

Year	Revenue, R	Operating expenses, OE	Basis, B and Salvage, s	CFBT	Depreciation, D	Taxable income, TI	Taxes at Te=0.184	CFAT
0			90000	-90000				-90000
1	65000	18500		46500	18000	28500	5244	41256
2	65000	18500		46500	18000	28500	5244	41256
3	65000	18500		46500	18000	28500	5244	41256
4	65000	18500		46500	18000	28500	5244	41256
5	65000	18500	0	46500	18000	28500	5244	41256

a) Before-Tax ROR = 43%
b) After-Tax ROR = 36%
c) Using IRR function, i = 43% and IRR Function, i = 36%
d) By approximation: After-Tax ROR = 43% x (1 – 0.1840) = 35%

Terminology

a) Profit vs. Loss
b) Revenue – Income earned as a result of providing product or services.
c) Expense – incurred as you do business.
d) Depreciation Expense – Capital expenditures must be capitalized.
e) Taxable Income = Gross income (revenues) – expenses
f) Income taxes = (Tax Rate) x (Taxable Income)
g) Net Income = Taxable Income x Income Taxes
h) Gains – an asset is sold for more than its cost basis and Losses an asset is sold for less than its cost basis.
i) Losses can't be used to offset operating income, but can offset capital gains (orpostponed until later years)

6.0 TAXATION AND PROJECT EVALUATION

Income taxes are real cash flow payments to the government levied against income & profits. The (noncash) allowance of asset depreciation is used in income tax computations.

1. Two fundamental relations: NOI & TI

Net Operating Income = Gross revenue – Operating expensesNOI
= GI – OE (only actual cash involved

"NOI is also calling as EBIT (earn before interest and taxes)"

Taxable Income = Gross revenue – Operating expenses – DepreciationTI

= GI – OE – D (involves noncash item)

"All items and relation are calculated for each year(t), but the subscript is oftenomitted for simplicity."

2. Gross income (GI) or operating revenue (OR) – Total income for the tax yearrealized from all revenue producing source.
3. Operating expenses (OE) – All annual operating costs (AOC) & maintenance & operating (M&O) costs incurred in transacting business; these are tax deductible;depreciation not included here.
4. Income taxes and tax rate (T) – Taxes due annually are based on taxable incomeTI and tax rates, which are commonly graduated (or progressive) by TI level.

Taxes = tax rate x taxable income

= T x (GI – OE – D)

5. Net operating profit after taxes NOPAT – money remaining as a result of capital invested during the year; amount left taxes are paid.

NOPAT = taxable income – taxes

= TI – T X (TI)

= TI X (1 – T)

Compare relations for individuals with corporations.

i. Gross Income (corporation: GI = all revenues):

GI = salaries + wages + interest & dividends + other income

ii. Taxable Income (corporation: TI = GI – OE – D):

TI = GI – Personal Exemption – standard or itemized deductions

iii. Taxes (individual & corporation rates are graduated by IT):

Taxed = Taxable income x tax rate = TI x T

Example 4: (Personal Income Tax)

Encik Abu is a doctor. His monthly income is RM 3000. His wife is a housewife, and he has 5 children. He also paid zakat RM 200. Calculate the tax he has to pay?

Details:

Personal: RM 8000

Wife: RM 2000

Children: RM 800/ person

KWSP: 11% (employee) 12% (employer)

Solution:

Details	Total (RM)
Personal	8000
Wife	2000
Children	4000
KWSP	3960
Total income tax	17040

Total income tax is RM17, 040.00

First 2500 x 0% = 0

Next 2500 x 1% = RM 25.00

Next 12040 x 3% = RM 361.20

Total RM 386.20

Deduct

Zakat = RM 200

Total tax to paid = RM 186.20

Net operating profit:

= AI – TI – KWSP – Z

= RM 3600 – RM 186.20 – RM3960 – RM 200

= RM 31 653. 38

Example 5:

Syarikat Gading Emas Sdn Bhd bought a machine with an initial cost of RM 150000 for auseful life of 5 years. The salvage is 10% of the initial cost. The income is RM 25000 yearly and the expenses RM 10000 yearly. The government charges a tax rate of 30% with the depreciation of Double Declining balance of 20%. Give an opinion on NPV of ATCF at the end of 5 years. The MARR after tax is 6%.

Solution:

Years	Income	Expenses	Depreciation 20%	Tax TI x 30%	Taxable Income (I – E- D)	ATCF (TI - E- T)
0		150000				-150000
1	25000	10000	30000	-4500	-15000	-20500
2	25000	10000	24000	-2700	-9000	-16300
3	25000	10000	19200	-1260	-4200	-12940
4	25000	10000	15360	-108	-360	-10252
5	25000	10000	12288	814	2712	-8101.60

Salvage 15000

Depreciation: (initial cost x accumulated depreciation) x depreciationYear 1 =

150000 x 0.2 = 30000

Year 2 = (150000 – 30000) x 0.2 =24000

Year 3 = (150000 – 30000 – 24000) x 0.2 = 19200

Year 4 = (150000 – 30000 – 24000 - 19200) x 0.2 = 15360

Year 5 = (150000 – 30000 – 24000 – 19200 – 15360) x 0.2 = 12288

Taxable income: (income – expenses – depreciation)Year 1: 25000 – 10000 – 30000

= -15000

Calculate until year 5 with same formula (I – E – D)

Taxation: (Taxable income x government charge tax)Year 1: -15000 x 30% = -4500

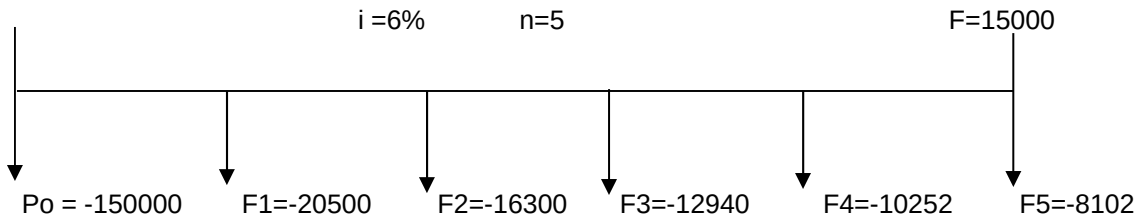
Calculate until year 5 with same formula (TI x charge tax rate)

ATCF: (taxable income – expenses – taxation)Year 1 = -15000 – 10000 – (-4500) = -20500

Year 2 = -9000 – 10000 – (-2700) = -16300

Calculate until year 5 with same formula (TI – E – T)

ATCF:



NPV = Po + F1(P/F,1,6) + F2 (P/F,2,6) + F3 (P/F,3,6) + F4 (P/F,4,6) + F5 (P/F,5,6)
= -150000 – 20500 (0.9434) – 16300 (0.8900) – 12940 (0.8396) – 10252 (0.7921) + 6898 (0.7473)
= - RM 197676.86 (It not feasible because NPV < 0)

Example 6

Syarikat Kuari Emas Sdn Bhd bought a machine with an initial cost of RM500,000 for a useful life of 5 years. The salvage is RM250,000. The income is RM350,000 yearly and the expenses RM100,000 yearly. The government changed tax rate of 40%, with the depreciation of Double Declining balance of 20%. Give and opinion of NPV of ATCF at the end of 5 years. The MARR after tax is 6%.

Solution:

Years	Income (RM)	Expenses (RM)	Depreciation (RM) 20%	Tax (RM) TI x 40%	Taxable Income (I – E- D)	ATCF (RM) (TI - E- T)
0	-	500000	-	-	-	-500000
1	350000	100000	100000	60000	150000	-10000
2	350000	100000	80000	68000	170000	2000
3	350000	100000	64000	74400	186000	11600
4	350000	100000	51200	79520	198800	19280
5	350000	100000	40960	83616	209040	25424

Salvage 250000

Depreciation: (initial cost x accumulated depreciation) x depreciationYear 1 = 500,000

x 0.2 = 100,000

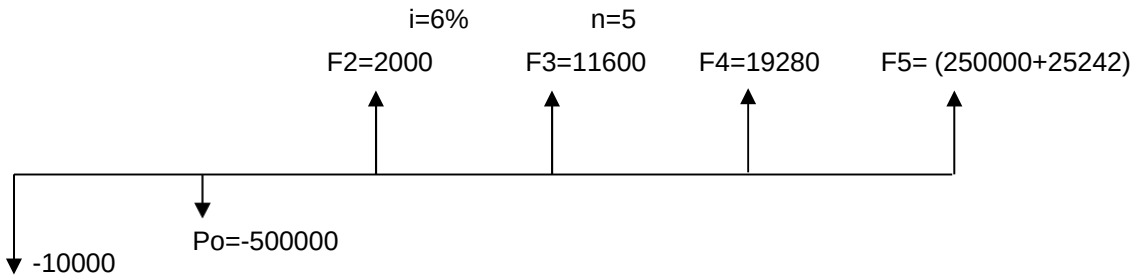
Year 2 = 0.2 x (500,000 – 100,000) = 80,000

Year 3 = 0.2 x (500,000 – 100,000 – 80,000) = 64,000

Year 4 = 0.2 x (500,000 – 100,000 –80,000 – 64,000) = 51,200

Year 5 = 0.2 x (500,000 – 100,000 – 80,000 – 64,000 – 51,200) = 40,960

ATCF:



NPV = -500,000 – 10,000 (P/F,6%,1) + 2,000 (P/F,6%,2) + 11,600(P/F,6%,3) + 19,280 (P/F,6%,4) + (250,000 + 25,424) (P/F,6%,5)

= -500,000 – 10,000 (0.3434) + 2,000 (0.8500) + 11,500 (0.8396) + 19,280 (0.7521) +275,424 (0.7473)

NPV = - RM276,818.60

*NPV < 0 (-ve). The machine give loss to company and its not feasible.

Example 7

Construct a table for a 3-year project to find the After-Tax Cash Flow (ATCF) and calculatethe Present Worth (PW) of ATCF using the details below:

a) Purchase price RM 700 000
b) Re – sale (salvage) RM 300 000
c) Income/Year RM 500 000
d) Expenses/Year RM 200 000
e) Asset is declining balance type, with depreciation rate of 20%
f) Tax rate 40%
g) MARR (after tax) 7.0%

Give your opinion on the PW of ATCF final result at the end of the third year.

Solution:

Years	Income (RM)	Expenses (RM)	Depreciation (RM) 20%	Tax (RM) TI x 40%	Taxable Income (I – E- D)	ATCF (RM) (TI - E- T)
0	-	700000	-	-	-	-700000
1	500000	200000	140000	64000	160000	-104000
2	500000	200000	112000	75200	188000	-87200
3	500000	200000	89600	84160	210400	-73760

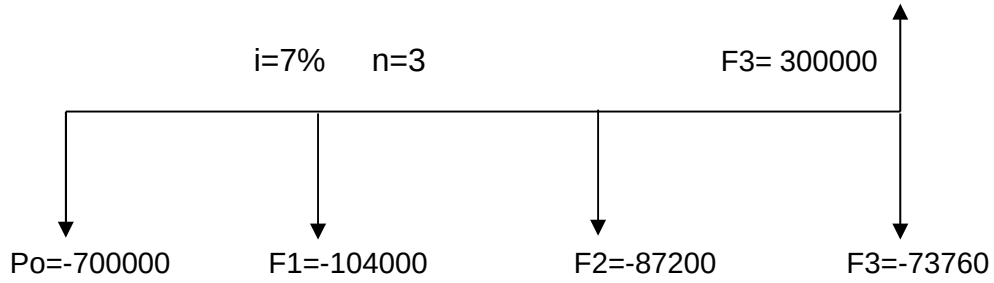
Salvage 300000

Depreciation: (initial cost x accumulated depreciation) x depreciationYear 1 = 700 000 x 0.2 = 140 000

Year 2 = (700 000 – 140 000) x 0.2 =112 000

Year 3 = (700 000 – 140 000 – 112 000) x 0.2 = 89 600

ATCF:



NPV = PV Benefits – PV costsPV benefits = F (P/F, 7%, 3)

= 300 000 x 0.8163

= RM 244 890

PV costs = Po (P/P) + F1 (P/F, 7%, 1) + F2 (P/F, 7%, 2) + F3 (P/F, 7%, 3)

= 700 000 (1) + 104 000 (0.9346) + 87 200 (0.8734) + 73 760 (0.8163)

= 700 000 + 97198.4 + 76160.48 + 60210.29

= RM 933 569.17

NPV = PV Benefits – PV costs

NPV = RM 244 890 - RM 933 569.17

NPV = RM 688 679.17

*It not feasible because NPV < 0

Example 8

Construct a table for a 3-year project to find the After-Tax Cash Flow (ATCF) and calculatethe Present Worth (PW) of ATCF using the details below:

a) Purchase price RM 600 000
b) Re-sale (salvage) RM 200 000
c) Income/Year RM 400 000
d) Expenses/Year RM 100 000
e) Asset is declining balance type, with depreciation of 20%
f) Tax rate 40%
g) MARR (after tax) 8.0%

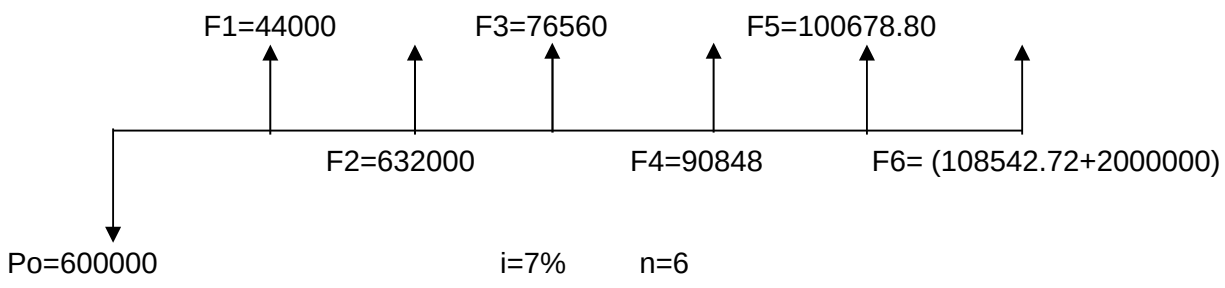
Give your opinion on the PW of ATCF final result at the end of the third year.

Solution:

Years	Income (RM)	Expenses (RM)	Depreciation (RM) 20%	Tax (RM) TI x 40%	Taxable Income (I – E- D)	ATCF (RM) (TI - E- T)
0	-	600000	-	-	-	-600000
1	400000	100000	120000	36000	180000	44000
2	400000	100000	96000	40800	204000	63200
3	400000	100000	76800	44640	223200	78560
4	400000	100000	61440	47712	238560	90848
5	400000	100000	49152	50169.60	250848	100678.40
6	400000	100000	39321.60	52135.68	260678.40	108542.72

Salvage 200000

ACTF



NPV = - 600000 (P/P) + 44000 (P/F, 7%,1) + 63200 (P/F, 7%,2) + 78560 (P/F, 7%,3) + 90848 (P/F, 7%,4) + 100768.80 (P/F, 7%,5) + 108542.72 (P/F, 7%,6) + 200000 (P/F,7%,6)

= - 600000 + 44000 (0.9346) + 63200 (0.8734) + 78560 (0.8163) + 90848 (0.7629) +100768.80 (0.7130) + 108542.72 (0.6663) + 200000 (0.6663)

= (-ve) RM92876.25

It is not feasible because NPV < 0

The net present value is (-ve) RM92876.25 which is less than 0.

Example 9:

Construct a table for a 3-year project to find the After-Tax Cash Flow (ATCF) and calculate the Present Worth (PW) of ATCF, if purchase price RM 700000, re-sale (salvage) RM 300000, income/Year RM 500 000, expenses/Year RM 200000, asset is Double Decliningbalance type, with depreciation rate of 30%. Tax rate 40%, MARR (after tax) 7.0%. Giveyour opinion on the PW of ATCF final result at the end of the third year.

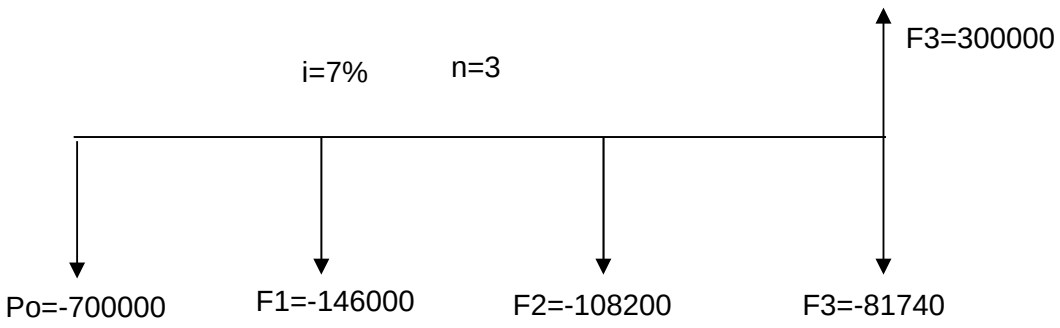
Solution:

Years	Income (RM)	Expenses (RM)	Depreciation (RM) 20%	Tax (RM) TI x 40%	Taxable Income (I – E- D)	ATCF (RM) (TI - E- T)
0	-	700000	-	-	-	-700000
1	500000	200000	210000	36000	90000	-146000
2	500000	200000	147000	61200	153000	-108200
3	500000	200000	102900	78840	197100	-81740

Salvage

300

ATCF:



NPV = - 700000 (P/P) – 146000 (P/F, 7%, 1) – 108200 (P/F, 7%, 2) – 81740 (P/F, 7%, 3) + 300000 (P/F, 7%, 3)

= - 700000 – 146000 (0.9346) – 108200 (0.8734) – 81740 (0.8163) + 300000 (0.8163)

= - RM 973188.84

= (-ve) RM 973188.84

It is not feasible because NPV < 0

The net present value is (-ve) RM973188.84 which is less than 0.

Capital Budgeting Decision Technique

a) Payback period: Most commonly used. Discounted Payback, not as common.
b) Net present value (NPV): Best technique theoretically; difficult to calculate realistically.
c) Internal rate of return (IRR): widely used with strong intuitive appeal. Modified IRR can be used if several neg. cashflows.
d) Profitability index (PI): related to NPV.

Capital Budgeting Process should:

a) Account for the time value of money;
b) Account for risk;
c) Focus on cash flow;
d) Rank competing projects appropriately, and
e) Lead to investment decisions that maximize shareholders' wealth.

Payback Period

The payback period is the amount of time required for the firm to recover its initial investment.

i. If the project's payback period is less than the maximum acceptable payback period, accept the project.

ii. If the project's payback period is greater than the maximum acceptable payback period, reject the project.

Management determines the maximum acceptable payback period.

Global Wireless

Global Wireless is a worldwide provider of wireless telephony devices. Global Wireless evaluating major expansion of its wireless network in two different regions:

a) Northern Malaysia expansion

b) A smaller investment in Eastern Malaysia to establish a toe hold.

Northern Malaysia (RM millions)	
Initial outlay	-RM 250
Year 1 inflow	RM 35
Year 2 inflow	RM 80
Year 3 inflow	RM 130
Year 4 inflow	RM 160
Year 5 inflow	RM 175

Eastern Malaysia (RM millions)	
Initial outlay	-RM 50
Year 1 inflow	RM 18
Year 2 inflow	RM 22
Year 3 inflow	RM 25
Year 4 inflow	RM 30
Year 5 inflow	RM 32

Calculating Payback Periods for Global Wireless Projects

Management selects a 2.75-year payback period. Northern Malaysia project has initialoutflow of -RM 250 million;

a) But cash inflows over first 3 years only RM 245 million.
b) Global Wireless would reject the Western Europe project.

Eastern Malaysia project: initial outflow of -RM 50 million

a) Cash inflows over the first 2 years cumulate to RM 40 million.
b) Project recovers initial outflow after 2.40 years.
c) Total inflow in year 3 is RM 25 million. We estimate that the projects generate RM10 million in year 3 in 0.40 years (RM 10 million ÷ RM 25 million).

Global Wireless would accept the project.Pro and Cons of Payback Method

Advantages of payback method:

a) Computational simplicity.
b) Easy to understand.
c) Focus on cash flow.

Disadvantages of payback method:

a) Does not account properly for time value of money.
b) Does not account properly for risk.
c) Cut-off period is arbitrary.
d) Does not lead to value-maximizing decisions.

Discounted Payback Period

Discounted payback accounts for time value:

a) Apply discount rate to cash flows during payback period.
b) Still ignores cash flows after payback period

Global Wireless uses an 18% discount rate.

Item	PV Factors (18%)	Northern Malaysia (RM millions)	Eastern Malaysia (RM millions)
PV Year 1 inflow	0.8475	RM 29.7	RM 15.2
PV Year 2 inflow	0.7182	RM 57.4	RM 15.8
PV Year 3 inflow	0.6086	RM 79.1	RM 15.2
Cumulative PV	**-**	**RM 166.2**	**RM 46.2**
Accept / reject	**-**	**Reject**	**Reject**

Net Present Value

The present value of a project's cash inflows and outflows. Discounting cash flows accounts for the time value of money. Choosing the appropriate discount rate accounts for risk.

$$\text{NPV} = 0 = \text{CF}_0 + \frac{\text{CF}_1}{(1+\text{r})} + \frac{\text{CF}_2}{(1+\text{r})^2} + \frac{\text{CF}_3}{(1+\text{r})^3} + \ldots + \frac{\text{CF}_\text{N}}{(1+\text{r})^\text{N}}$$

Accept projects if NPV > 0

Calculating NPVs for Global Wireless Project

Assuming Global Wireless uses 18% discount rate, NPVs are:

Northern Malaysia project: NPV =RM 75.3 million

Eastern Malaysia project: NPV = RM 25.7 million

$$NPV_{Eastern\ Malaysia} = RM\ 25.7 = -50 + \frac{18}{(1.18)} + \frac{22}{(1.18)^2} + \frac{25}{(1.18)^3} + \frac{30}{(1.18)^4} +$$

Should Global Wireless invest in one project or both?

Pros and Cons of Using NPVs as Decision Rule

NPV is the "gold standard" of investment decision rules. Key benefits of using NPV asdecision rule:

a) Focuses on cash flows, not accounting earnings.
b) Makes appropriate adjustment for time value of money.
c) Can properly account for risk differences between projects

Though best measure, NPV has some drawbacks:

a) Lacks the intuitive appeal of payback, and
b) Doesn't capture managerial flexibility (option value) well

Internal Rate of Return

Internal rate of return (IRR) is the discount rate that results in a zero NPV for the project

$$\text{NPV} = 0 = \text{CF}_0 + \frac{\text{CF}_1}{(1+\text{r})} + \frac{\text{CF}_2}{(1+\text{r})^2} + \frac{\text{CF}_3}{(1+\text{r})^3} + \ldots + \frac{\text{CF}_\text{N}}{(1+\text{r})^\text{N}}$$

IRR found by computer/calculator or manually by trial and error.The IRR decision rule is:

a) If the IRR is greater than the cost of capital, accept the project.
b) If the IRR is less than the cost of capital, reject the project.

Calculating IRRs for Global Wireless Project

Global Wireless will accept all projects with at least 18% IRR.

Northern Malaysia project: IRR (r_{wr})=27.8%

$$0 = -250 + \frac{35}{(1+r_{WE})} + \frac{80}{(1+r_{WE})^2} + \frac{130}{(1+r_{WE})^3} + \frac{160}{(1+r_{WE})^4} + \frac{175}{(1+r_{WE})^5}$$

Eastern Malaysia: IRR (r_{se})=36.7%

$$0 = -50 + \frac{18}{(1+r_{SE})} + \frac{22}{(1+r_{SE})^2} + \frac{25}{(1+r_{SE})^3} + \frac{30}{(1+r_{SE})^4} + \frac{32}{(1+r_{SE})^5}$$

Advantages and Disadvantages of IRR

Advantages of IRR	Disadvantages of IRR
a) Properly adjusts for time value of money. b) Uses cash flows rather than earnings. c) Accounts for all cash flows d) Project IRR is a number with intuitive appeal	a) "Mathematical problems": multiple IRRs, no real solutions b) Scale-problem c) Timing problem

Multiple IRRs

When project cash flows have multiple sign changes, there can be multiple IRRs (Figure 6.1). With multiple IRRs, which do we compare with the cost of capital to accept/reject the project?

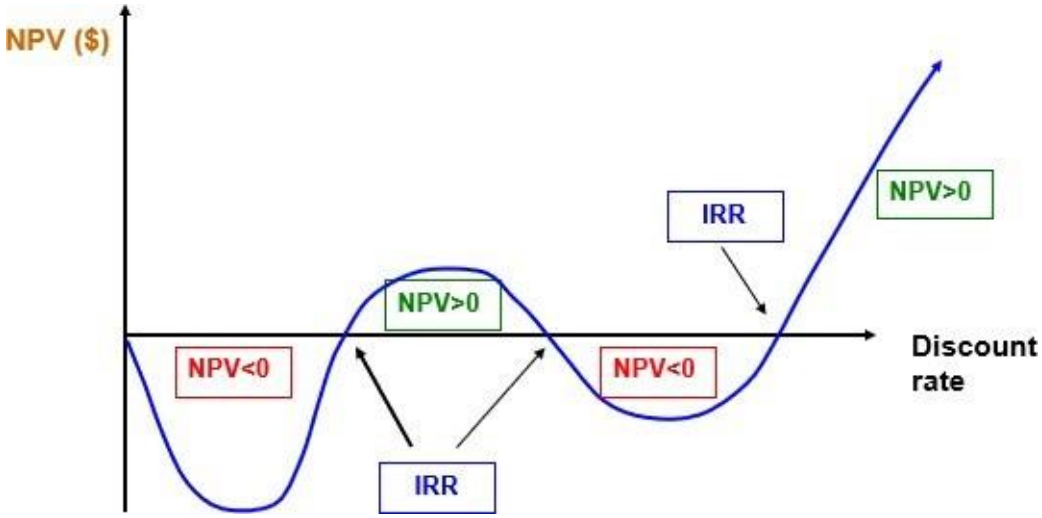


Figure 6.1: multiple IRRs

No Real Solution

Sometimes projects do not have a real IRR solution. Modify Global Wireless's Western Europe project to include a large negative outflow (-$355 million) in year 6.

a) There is no real number that will make NPV=0, so no real IRR. However, can usesomething called modified IRR.

Project is a bad idea based on NPV. At r =18%, project has negative NPV, so reject!

Conflict between NPV and IRR

NPV and IRR do not always agree when ranking competing projects. The scale problem:

Project	IRR	NPV (18%)
Northern Malaysia	27.8%	$75.3 mil
Eastern Malaysia	36.7%	$25.7 mil

Southeast U.S. project has higher IRR but doesn't increase shareholders' wealth as much as Western Europe project.

The Timing Problem

The NPV of the long-term project is more sensitive to the discount rate than the NPV of the short-term project is (Figure 6.2). Long-term projects have higher NPV if the cost of capital is less than 13%. Short-term projects have higher NPV if the cost of capital is greater than 13%.

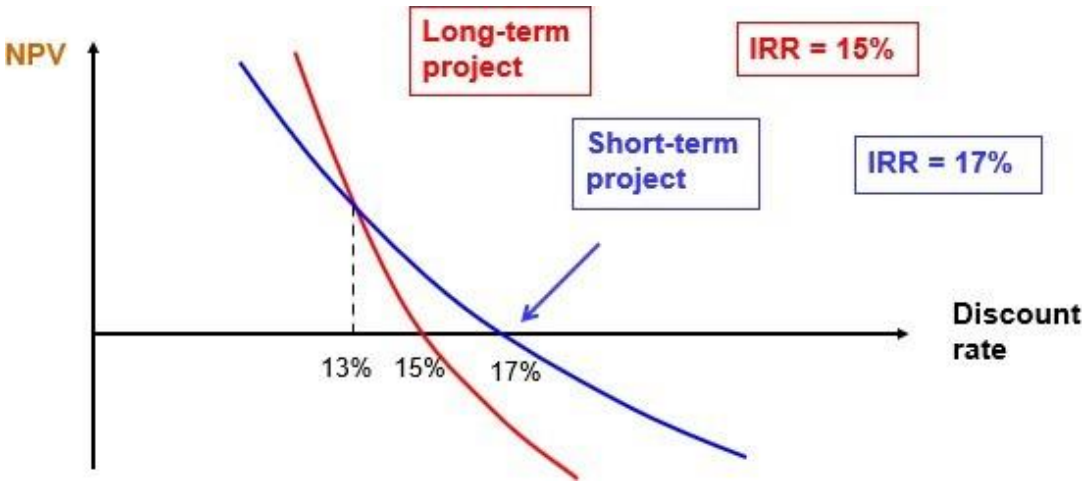


Figure 6.2: The Timing Problem

Profitability Index

Calculated by dividing the PV of a project's cash inflows by the PV of its outflows:

$$PI = \frac{\frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_N}{(1+r)^N}}{CF_0}$$

Decision rule: Accept project with PI > 1.0, equal to NPV > 0

Project	PV of CF (yrs1-5)	Initial Outlay	PI
Northern Malaysia	RM 325.3 million	RM 250 million	1.3
Eastern Malaysia	RM 75.7 million	RM 50 million	1.5

Both projects' PI > 1.0, so acceptable if independent. Like IRR, PI suffers from the scale problem.

Comparison applied method

According to the technical literature, the limits mostly occur in three areas

a) The ranking of investment proposals of diverse sizes, excluding each othermutually;
b) The evaluation investments that have non-conventional cash-flows;
c) The adjudication of investments excluding each other mutually and having time- differing structured cash-flows. We carry out the analysis of problematic areas withthe help of numerable data.

Example 10:

A producer can choose from two investments and there is a significant – two and a half fold – difference between the starting capital investments. The minimum required profit need of the investments is 12%. The useful lifespan is 4 years. The first investment version can be realized by a 50 million HUF capital engrossment and results in an average net yield of 21.2 million HUF every year. The second investment version needs a 125 million HUF capital investment and results in the realization of an average net yield of 48.3 million HUF every year. Evaluate the investment variations excluding each other mutually based on the inner rate of return and the net present value.

Table 10.1 Comparisons of interview version

Unit: million HUF

Investment variations	B	H (n=4 years)	NPVD'=0	IRR	NPV
B1	50.0	21.2	34.8	25%>12%	+14.4>0
B2	125.0	48.3	68.2	20%>12%	+21.7>0

$$q_1 = \frac{21.2}{50.0} = 0.424 \rightarrow q_{1\,4year} = 0.4234 \rightarrow 25\%$$

$$-50 + \left(\frac{21.2}{0.4234}\right) = -50 + 50 = 0$$

$$NPV_1 = -50 + (21.2\ x\ 3.037) = -50 + 64.4 = +14.4$$

$$q_2 = \frac{48.3}{125.0} = 0.3864 \rightarrow q_{1\,4year} = 0.3863 \rightarrow 20\%$$

$$-125 + \left(\frac{48.3}{0.3863}\right) = -125 + 125 = 0$$

$$NPV_2 = -125 + (48.3\ x\ 3.037) = -125 + 146.7 = +21.7$$

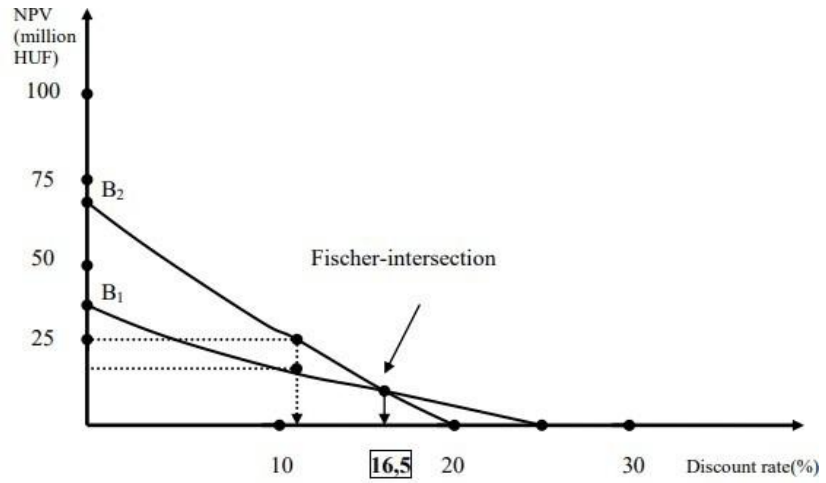


Figure 10.1: NPV and IRR Values of Investment Version

Both investment variations can be considered profitable based on the inner rate of returnas well as based on the net present value. However, it is interesting that the first versionis more favorable based on the inner rate of return while the second variation is more favorable based on the net present value. In this case the different results of the two methods can be explained by the significant difference in the cash-flows of the two investment versions (Incidentally we have to note that between the investment versions excluding each other mutually there are hardly any big differences in size in practice, sothe decision maker rarely faces this problem).

The technical literature suggests in similarcases that we should decide based on the absolute value of the net present value since the inner rate of interest is insensitive to the dimension of investments so therelative efficiency (rate) can mislead the investor. Before deciding, we delineate the values of the NPV and the inner rate of return characteristic for the two investment versions in a frame of reference (Figure 4).

The Fisher-intersection shows the discount rate in the frame of reference at which the twoinvestment alternatives have a similar consideration based on the sum of the net presentvalues. This is the so-called “neutral discount rate” which is 16.5% in the present case. Inorder to see clearly and to make a good decision we have to analyze the net present values of the investment alternatives at discount rates of 12, 16.5 and 19%.

Table 10.2: Analysis of investment versions in case of diverse rates of discount

Unit million HUF

Investment alternative	NPV (12%)	NPV on 1 HUF capital (HUF)	NPV D’=0	NPV (19%)	IRR
B1	+14.4	0.29	-50+(21.2 x 2.77049) + 8.7	-50+(21.2 x 2.639) + 6.0	25%
B2	+21.7	0.17	-125+(48.3 x 2.77049) + 8.8	-125+(48.3 x 2.639) + 2.5	20%

$$A^{t}{}_{4years,}\ 16.5\% = \frac{1}{0.165} - \frac{1}{0.165(1.165)^4} = 6.06061 - 3.29012 = 2.77049$$

$$A^{t}{}_{4years,}\ 19\% = 2.639$$

We can determine from the results of the calculations that at a calculative rate of interest lower than the “neutral discount rate” determined by the Fischer-intersection investment version B2 shows a higher NPV. This capital demanding topic realizes 7.3 million HUF more excess profit, not because it is more efficient but because its starting capital engrossment is much higher. If we consider the net present value on 1 HUF of capital, version B1 looks more favorable. The average profitability on capital is 5% higherwhich also shows an advantage of alternative B1.

The NPV principle considers the two investment alternatives equal in the Fischer-intersection. However, it is obvious that version B1 is more favorable. On the one hand, its specific NPV is higher; on the other hand, the creation of the same excess profit at a capital engrossment of 40 % lower level is an incomparably better result. In case a minimum yield needs greater than the neutral discount rate (19%) the advantage of versionB1 is reflected in the NPV.

We can draw the conclusion from the above-mentioned data that the absolute valueof the net present value can be misleading in making economic decisions. On the one hand, it is because the NPV cannot be independent from the value of the capital engrossment – the comparison of the investment variations is impossible without a common denominator, on the other hand, the amount of the excess profit created is undeterminable without the knowledge of the useful lifespan.

In summary we can say that we should not make investment decisions based on the absolute value of the net present value suggested widely in the technical literature, but we should take into consideration the tendencies happening in the economic environment, the relations of the neutral discount rate and the calculative rate of interest, the entrepreneurial and bank requirements about profitability and the value of the capital engrossment and its duration.

Example 11:

We know from the relevant professional literature that the results of dynamic investment-profitability calculations are not reliable in the case of non-typical, that is not conventional, cash-flows.In the case of a typical investment there is only one internal rate of interest. If the cash-flows change signs several times during the useful lifespan of the investment, moreIRR values are created while the NPV is zero. This problem makes the work of the decision-making financial expert more difficult since the known IRR values cannot be compared with the profit need of the company in many cases. Some experts suggest using the net present value principle to solve this problem.

The starting cash-flow of an investment is 1.6 million HUF. We can calculate 10 million HUF net yields in the first year and with -10 million HUF net yields in the second year. Can an investment that gives a huge yield in the long run but causes great costs ina longer time period be acceptable from an economic perspective? (The calculative rate of interest of the business enterprise is 20%).

$$\frac{10}{x} - \frac{10}{x^2} = \frac{1.6}{x^2}$$

$$1 + \text{IRR} = x$$

$$\text{IRR} = x - 1$$

$$10x - 10 = 1.6x^2$$

$$1.6x^2 - 10x + 10 = 0$$

$$x_{1,2} = \frac{10 + \sqrt{100-64}}{3.2} = \frac{10 + \sqrt{36}}{3.2}$$

$$x_1 = \frac{10+6}{3.2} = 5 \rightarrow 400\%$$

$$x_2 = \frac{10-6}{3.2} = 1.25 \rightarrow 25\%$$

From an economic perspective, the rate of 400 % is unreal. However, an IRR value of 25% is imaginable.

$$NPV_{400} = -1.6 + \frac{10}{5} - \frac{10}{25} = -1.6 + 2 - 0.4 = 0$$

$$NPV_{25} = -1.6 + \frac{10}{1.25} - \frac{10}{1.5625} = -1.6 + 8 - 6.4 = 0$$

At the inner rates of return (25%, 400%) the NPV turned out to be zero. Calculate the NPV at average risk rate with the help of the calculative rate of interest.

$$NPV_{20} = -1.6 + \frac{10}{1.20} - \frac{10}{1.44} = -1.6 + 8.3 - 6.9 = -0.2\ MFt$$

Calculate the NPV in the case of a very risky capital engrossment if the calculative rate of interest is 30%.

$$NPV_{30} = -1.6 + \frac{10}{1.3} - \frac{10}{1.69} = -1.6 + 7.7 - 5.9 = +0.2\ M\ Ft$$

We get a very surprising net present value at the given calculative rates of interest. At acalculated asset need of 20% including the smaller risk offset, according to the net presentvalue principle, the investment has to be rejected since the NPV is negative. If we can engross our capital permanently at a very high-risk rate – the calculative rate of interest is 30%, the NPV is positive so the investment can be considered profitable.It is not hard to see the reason that the above-mentioned investment must not be realized ata calculative rate of interest of 30%. We can establish, using the data we got, that neitherthe inner rate of return nor the net present value calculations help economic discernment in case of non-typical investments.

Example 12:

From the aspect of investment-profitability calculations the situation in which the investments excluding each other mutually can be characterized by significantly differentstructures of cash-flow in time can be seen as a problematic area. According to the suggestions in the technical literature we have to make investment decisions using the net present value principle.

An entrepreneur has to choose from two investment alternatives (Table 12.1). The investments concerned exclude each other mutually but have significantly diverse structures of cash-flow in time. The calculative rate of interest is 12%.

Table 12.1: Cash Flow of investment versions

Unit: thousand HUF

Years	B1	B2
0	-25000	-25000
1	18000	1500
2	13000	2540
3	3000	15500
4	1815	27000

Which investment variation should the entrepreneur realize? Make your decision based on the NPV and the IRR values. By way of introduction, we have to mention that in the case of investments carried out for the same reason, it is very rare that an investor should face two cash-flows movingin the opposite direction in their tendencies. The above-mentioned case will hardly ever happen in practice, so it only has a theoretical importance.

Table 12.2: Net present value (NPV) of investment versions

Unit: thousand HUF

Years	B1 Cash-flow (0%)	B2 Cash-flow (0%)	Discount factor (12%)	B1 present value	B2 present value
0	-25000	-25000	-	-25000	-25000
1	18000	1500	0.89286	16071.5	1339.3
2	13000	2540	0.79719	10363.5	2024.9
3	3000	15500	0.71178	2135.3	11032.6
4	1815	27000	0.63552	1153.5	17159.0
NPV	+10815	+21540	-	+4.724	+6555.8

Table 12.3: Internal rate of return (IRR) of investment versions

Unit: thousand HUF

Years	B1 Cash-flow	B2 Cash-flow	Discount factor (25%)	B1 present value	B2 discount factor (20%)	B2 present value
0	-25000	-25000	-	-25000	-	-25000
1	18000	1500	0.80000	14400	0.83333	1250
2	13000	2540	0.64000	8320	0.69444	1763
3	3000	15500	0.51000	1536	0.57870	8970
4	1815	27000	0.40960	743	0.48225	13020
NPV	-	-	-	~0	-	~0

As we can see from the results, version B2 can be considered more favorable based onthe NPV while version B1 is more favorable based on the inner rate of return (Tables 12.2 and 12.3). In order to compare the two versions, let us analyze the value of the “neutral discount rate”.

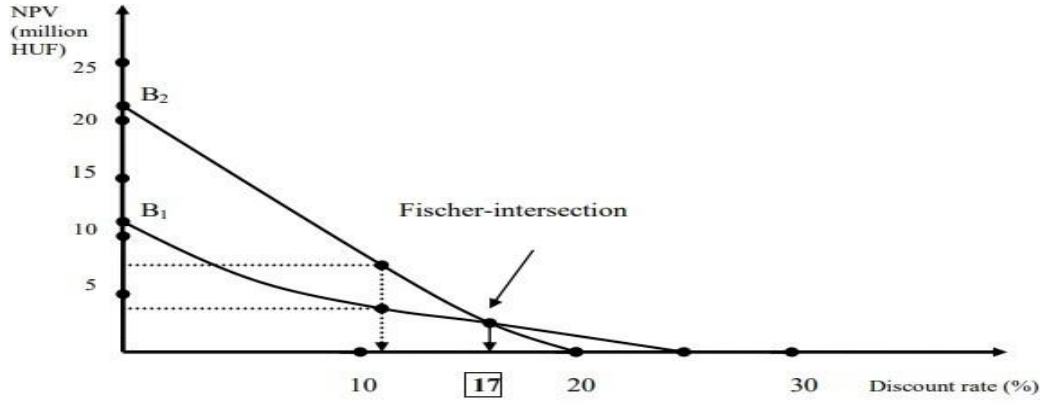


Figure 10.1: NPV and IRR Values of Investment Version

The Fischer-intersection shows that at a discount rate of approximately 17% the twoinvestment versions produce a nearly equal net present value.

Table 12.4: Comparing the results of investment versions

Investment versions	NPV (thousand HUF) (12%)	NPV on 1 HUF capital (HUF)	NPV (thousand HUF) (17%)	IRR
B1	+4,724.0	0.19	+2.73	25%
B2	+6,555.8	0.26	+2.23	20%

If the calculative rate of interest of 12% reflects the offset of the risks in connection with the investment very well, the realization of version B2 in more feasible since the net yields created during usage mean greater asset increase and their re-engrossment at 12% can be provided with great certainty. If the risk of investment is growing because of the economic environment – this, of course, comes along with the increase in the value of the calculative rate of interest, we have to prefer version B1 since the back-flow and the re-engrossment of the greater net yields near the date of activation is more favorable, even at a yield rate above the calculative rate of interest.

The main conclusions that can be drawn after the analysis of the above-mentioned problematic areas:

a) The results of the decision made based on the absolute amount of NPV can differ according to the values of the calculative rate of interest.
b) The decision made based on the NPV can be misleading because, on the one hand, the net present value cannot be independent from the value of the capital engrossment; on the other hand, the excess profit above the rate of return need cannot be interpreted without taking the useful life-span into consideration.
c) The determination of the so-called “neutral discount rate” is inevitable in order to make a relevant decision.

In summary we can determine that the investment-profitability decisions need the knowledge of the NPV expressing the measure of asset growth during the useful life-spanas well as the knowledge of the IRR value reflecting profitability on capital. The two piecesof information together guarantee the making of relevant decisions.