Aalto University
School of Business

Capital Budgeting (22E12000)

Evaluating Capital Investments (A)

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- Internal Rate of Return
- Comparison of NPV & IRR
- Payback method
- Accounting Rate of Return
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Measuring Investment Value & Alternative Methods of Evaluating Capital Investments

Shareholder Value Approach: Wealth Maximization

Investment project evaluation criteria:

- Focus only on cash flow
- Time value of money integrated
- Must account for risk

→ **Net Present Value approach is consistent**

Capital Budgeting Techniques

(see also Chapters 4-5 in the Course book)

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period
- Accounting Rate of Return (ARR)
- Profitability index

Discounted Cash Flows

Discounted Cash Flow (DCF) methods measure all expected future cash inflows and outflows of a project as if they occurred at a single point in time

The key feature of DCF methods is the time value of money (interest), meaning that a dollar received today is worth more than a dollar received in the future

Discounted Cash Flows

Discounted Cash Flow (DCF) methods use the Required Rate of Return (RRR), which is the minimum acceptable annual rate of return on an investment

RRR: return than an organization could expect to receive elsewhere for an investment of comparable risk (opportunity cost of capital)

RRR: also called the discount rate, hurdle rate, cost of capital

Components in Investment Calculations (DCF analysis)

In investment calculation

- Initial investment outlay
- Annual cash flows from operations
- Useful life
- Terminal disposal (residual) value of investment
- Required rate of return (discount/interest/hurdle rate)
- Working capital changes

Qualitative factors (not incl. in calculations)

- E.g. strategic, safety, social, ergonomic aspects

Comparison of NPV and IRR

(See Appendix 1 for NPV and IRR calculation techniques)

NPV is preferred to IRR because:

- IRR can incorrectly rank mutually exclusive projects.

	IRR	NPV
	%	€
Project A	22	1 530
Project B	18	1 728

- IRR is expressed in percentage terms:

  Investment Y (1 year life) yields a return of 50% (I_0 = €100) =€50

  Investment Z (1 year life) yields a return of 25% (I_0 = €1 000) =€250

- IRR assumes internal cash flows are reinvested at the IRR, whereas NPV assumes they are invested at the cost of capital (→ Modified IRR, MIRR).
- Unconventional cash flows (–, + ,–) can result in multiple rates of return

Payback Period Method

- Measures the length of time that is required for a stream of cash flows from an investment to recover the original investment outlay

	Year 0 €000's	**Year 1** €000's	**Year 2** €000's	**Year 3** €000's	**Payback**	**NPV (10%)**
A	-400	+400			1 year	-36 364
B	-400	+200	+200	+1000	2 years	+698 422

Accounting Rate of Return Method (ARR)

- ARR Method divides an accrual accounting measure of average annual income of a project by an accrual accounting measure of its investment
- Easy to understand, and use (often) numbers reported in financial statements
- Does not track cash flows
- Ignores time value of money
- Many different variations to calculate ARR

Accounting Rate of Return Method (ARR)

For example (According to Shapiro, 2005):

Cumulative after tax profit/years

(Initial outlay + ending book value)/2

E.g. (400/4 years) / (700 + 100)/2

= 100/400 = 25%

Use of Different Techniques in Practice

(Bhimani et al., 2008, p. 431; Overall usage-% & Priority order per country)

	% of usage overall	Canada	France	Germany	Italy	UK	USA
Payback	70	1	1	3	1	1	1
IRR	69	4	2	1	2	2	2
NPV	71	2	3	2	3	4	3
ARR	26	3	4	4	4	3	4

Use of Different CAPBUD Techniques among the Largest Finnish Firms (Huikku, Karjalainen, Seppälä and Mäkinen, 2021)

	1.	2.	3.	Not among 3
a) Net present value (NPV)	33 %	18 %	16 %	33 %
b) Internal rate of return (IRR)	22 %	27 %	18 %	33 %
c) Payback, non-discounted	18 %	2 %	24 %	56 %
d) Payback, discounted	18 %	24 %	18 %	40 %
e) Accounting rate of return (e.g. ROI, ROCE)	2 %	16 %	11 %	71 %
f) Other, please specify	7 %	13 %	13 %	67 %

Capital Rationing (CR)

(see also Chapter 6 in the Course book)

Refers to situation where investment funds are restricted

- Soft capital rationing (self-imposed)
- Hard capital rationing (externally imposed constraints)

Not possible to accept all positive NPV projects

We have to rank projects

Ranking can be done e.g. by using Profitability index

Capital Rationing (CR)

Two major ways for Capital Rationing

- Hurdle rate higher than the cost of capital
- Fixed capital investment budget

Capital rationing

- May reduce agency problems: overinvestment & understating future performance,
- But it may increase the pressure to present biased information (may lead to a reputation loss)
- Comparisons between heterogeneous divisions challenging

Profitability Index (PI)

- Not always possible to accept all positive NPV projects (Capital rationing) → We have to rank projects
- Present values can be presented as a benefit- cost ratio
- PI = Present value/investment outlay
- Must exceed 1
- E.g.:

  X: 379,100/286,400 = 1.33

  Y: 614,500/419,200 = 1.47

  Z: 760,600/509,200 = 1.49 (The Best based on PI)

  -> Ranking order analysis

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Capital Budgeting (22E12000)

Project Cost of Capital

Estimating Project Cash Flows

Project Cost of Capital

(see also Chapter 18 in the Course book)

Cost of capital is the minimum risk adjusted return required by shareholders for undertaking the investment project

In investment calculations we should focus on Project's RRR, not on the RRR for the firm as a whole

Elements of cost of capital for a project:

- Real interest rate
- Inflation premium
- Risk premium

Some companies use different RRR for different investment categories and/or divisions

Project Cost of Capital (PCC)

- Capital asset pricing model (CAPM) based calculation of project cost of capital (all equity financed –approach)

  PCC = Risk free interest rate + Project risk premium

- Risk free interest rate: e.g. Treasury bond rate
- Project risk premium = Beta * (Required return – Risk free interest rate)
- Required return (historically for equity: risk free interest rate + 4-6%)
- Beta: over 1 if project is riskier than market portfolio average, difficult to estimate for a project

- E.g. PCC : 5.5% + 1.15 (12.5% - 5.5%) = 13.6%

Weighted Average Cost of Capital (WACC)

- Takes into consideration targeted capital structure and tax effects
- Target weights for capital components & market values should be used!

	Proportion of capital	Before-Tax cost (%)	After –Tax cost (%)	Weighted cost (%)
Equity	0.50	14	14	7
Debt	0.50	14	8	4
	1.00		WACC	11

RRR determination for NPV calculations in eight large Finnish companies (Eerola, 2023)

	A	B	C	D	E	F	G	H
Type of RRRs used	RRRs per project type	Fixed RRR Premium above Corp. WACC	RRRs per project type Project specific RRR	Fixed RRR Project specific RRR	BIZ segment WACC Corp. WACC	Corp. WACC	Corp. WACC	BIZ segment WACC Project specific RRR
Use of CAPM in RRR determination	Informally	Rarely	Yes	Yes	Yes	Yes	Yes	Yes
Use of WACC formula in RRR determination	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Subjectivity in RRR determination	High	High	High	Very high	Low	Medium	High	Medium

Relevant Cash Flows (see also Chapter 10 in the Course book)

Shareholders are interested in incremental cash flows

Total cash flows vs. Incremental cash flows

Reasons for differences:

1. Cannibalization

- New products taking sales away from the existing products

2. Sales creation

- Investment creates additional sales for other products

3. Opportunity cost

- The cash the asset could generate for the firm should it be sold or put to some other productive use
- Use the true cost of any required resource for the project

Relevant Cash Flows

Reasons for differences (continues):

4. Sunk cost

- Decisions should be based on future costs and benefits alone

5. Transfer pricing

- Market prices should be used for internal transactions
- Tax considerations often involved

6. Allocated overhead

- A project should be charged only for the additional expenditures
- The existing overheads should not be reallocated to the project

Relevant Cash Flows

Base Case	Getting the base case right • What will happen if we do not make this investment • Sometimes avoiding cannibalism may open doors to competitors
Intangibles	Accounting for Intangible benefits (qualitative aspects) • Learning experiences (e.g. new markets, new investments) • Qualitative aspects

Capital Budgeting and Inflation

Inflation has to be taken into consideration in the calculations

Two alternatives:

- Use Nominal cash flows & Nominal discount rates (inflation is included) OR
- Use Real cash flows & Real discount rates (inflation is excluded)

Remember the consistency; do not mix!

Terminal Value Estimation

- Terminal value (TV) can play a major role in calculations
- We may want to estimate the cash flow effects after evaluation period

Formula for TV:

Cash flow of the last evaluation period /
(RRR – Projected cash flow growth)

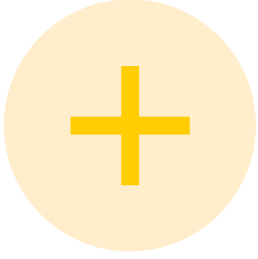
E.g.: 3138/(0.24-0.05) = about 16 516 (See the next page!)
(Last year (6th) cash flow 3138; grows at 5% indefinitely)
- TV has to be discounted to Year 0: 16 516 * 0.275 = 4 542
(DF24%, 6y. = 0.275)
- Sensitivity analysis: above 6% growth rate needed for break-even
(NPV without TV is -4963)

Terminal Value Estimation

	Year	Capital Equipment	Profit After Tax + Deprec	Working Capital	Total Cash Flow	PV @24%
0		-3000	-1950	0	-4950	-4950
1			-1119	-750	-1869	-1507
2			588	-2250	-1663	-1081
3			2066	-1950	116	61
4			3090	-1350	1740	736
5			3283	-600	2683	915
6			3738	-600	**3138**	863
					NPV	-4963

Appendix 1:

DISCOUNTING



NET PRESENT VALUE (NPV)

INTERNAL RATE OF RETURN (IRR)

Discounting

- Process of converting future cash flows into a value at the present time
- Year n cash flow discounted to the present time:

  $K_0 = K_n/(1+i)^n$

  K_0 = cash flow year 0 (now), K_n =cash flow year n

  E.g. n is 2 (years) ja K_n is 1 (mill.), i is 10%

  $1/(1+0.1)^2 = 1/1.21 = 0.82645$

  → 1 000 000 in year 2 is now worth only 826 450

Net Present Value (NPV) Method

NPV method calculates the expected monetary gain or loss from a project by discounting all expected future cash inflows and outflows to the present point in time, using the Required Rate of Return

Based on financial factors alone, only projects with a positive NPV are acceptable

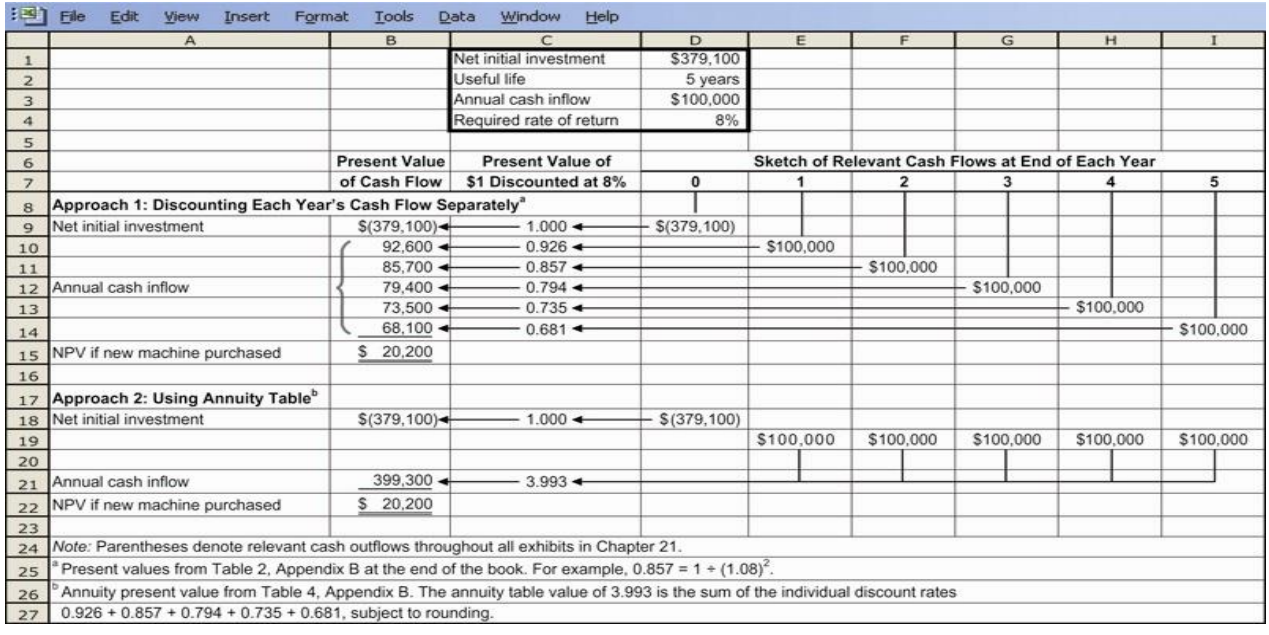
Three-Step NPV Method

Draw a sketch of the relevant cash inflows and outflows

Convert the inflows and outflows into present value figures using tables or a calculator

Sum the present value figures to determine the NPV. Positive or zero NPV signals acceptance, negative NPV signals rejection

NPV Example



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	A	B	C	D	E	F	G	H	I
1			Net initial investment	$379,100					
2			Useful life	5 years					
3			Annual cash inflow	$100,000					
4			Required rate of return	8%					
5									
6		Present Value	Present Value of	Sketch of Relevant Cash Flows at End of Each Year					
7		of Cash Flow	$1 Discounted at 8%	0	1	2	3	4	5
8	**Approach 1: Discounting Each Year's Cash Flow Separately[a]**								
9	Net initial investment	$(379,100)	1.000	$(379,100)					
10		92,600	0.926		$100,000				
11		85,700	0.857			$100,000			
12	Annual cash inflow	79,400	0.794				$100,000		
13		73,500	0.735					$100,000	
14		68,100	0.681						$100,000
15	NPV if new machine purchased	$ 20,200							
16									
17	**Approach 2: Using Annuity Table[b]**								
18	Net initial investment	$(379,100)	1.000	$(379,100)					
19					$100,000	$100,000	$100,000	$100,000	$100,000
20									
21	Annual cash inflow	399,300	3.993						
22	NPV if new machine purchased	$ 20,200							
23									

Note: Parentheses denote relevant cash outflows throughout all exhibits in Chapter 21.

[a] Present values from Table 2, Appendix B at the end of the book. For example, $0.857 = 1 \div (1.08)^2$.

[b] Annuity present value from Table 4, Appendix B. The annuity table value of 3.993 is the sum of the individual discount rates 0.926 + 0.857 + 0.794 + 0.735 + 0.681, subject to rounding.

NPV Example

Example (€000's)

NPV = €300/1.10 + €1 000/$(1.10)^2$ + €400/$(1.10)^3$ - €1 000 = €399.7

or use the discount tables

Year	€000's	Disc. Factor	PV
1	300	0.9091	272 730
2	1 000	0.8264	826 400
3	400	0.7513	300 520
			1 399 650
Less investment cost			1 000 000
NPV			399 650

Sensitivity Analysis, Example Variations in RRR and Annual Cash Flows: Effect on NPV

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	A	B	C	D	E	F
1	**Required**	**Annual Cash Flows**				
2	**Rate of Return**	**$ 80,000**	**$ 90,000**	**$100,000**	**$110,000**	**$120,000**
3	6%	$(42,140)	$ (20)	$ 42,100	$ 84,220	$126,340
4	8%	$(59,660)	$(19,730)	$ 20,200	$ 60,130	$100,060
5	10%	$(75,820)	$(37,910)	$ 0	$ 37,910	$ 75,820
6						
7	[a]All calculated amounts assume the project's useful life is five years.					

Internal Rate of Return (IRR)

The IRR method calculates the discount rate at which the present value of expected cash inflows from a project equals the present value of its expected cash outflows

A project is accepted only if the IRR equals or exceeds the RRR

IRR

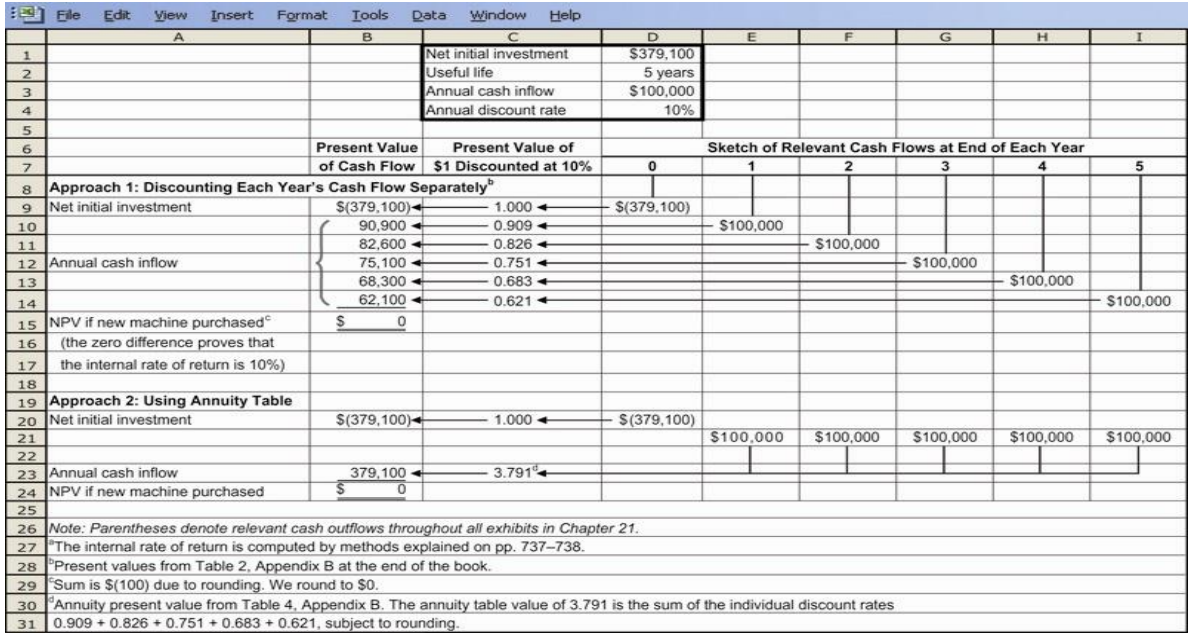
Analysts use a calculator or computer program to provide the IRR

Trial and Error Approach:

Use a discount rate and calculate the project's NPV. Goal: find the discount rate for which NPV = 0

- If the calculated NPV is greater than zero, use a higher discount rate
- If the calculated NPV is less than zero, use a lower discount rate
- Continue until NPV = 0

IRR Illustration



	A	B	C	D	E	F	G	H	I
1			Net initial investment	$379,100					
2			Useful life	5 years					
3			Annual cash inflow	$100,000					
4			Annual discount rate	10%					
5									
6		Present Value	Present Value of	Sketch of Relevant Cash Flows at End of Each Year					
7		of Cash Flow	$1 Discounted at 10%	0	1	2	3	4	5
8	**Approach 1: Discounting Each Year's Cash Flow Separately[b]**								
9	Net initial investment	$(379,100)	1.000	$(379,100)					
10		90,900	0.909		$100,000				
11		82,600	0.826			$100,000			
12	Annual cash inflow	75,100	0.751				$100,000		
13		68,300	0.683					$100,000	
14		62,100	0.621						$100,000
15	NPV if new machine purchased[c]	$ 0							
16	(the zero difference proves that								
17	the internal rate of return is 10%)								
18									
19	**Approach 2: Using Annuity Table**								
20	Net initial investment	$(379,100)	1.000	$(379,100)					
21					$100,000	$100,000	$100,000	$100,000	$100,000
22									
23	Annual cash inflow	379,100	3.791[d]						
24	NPV if new machine purchased	$ 0							
25									
26	*Note: Parentheses denote relevant cash outflows throughout all exhibits in Chapter 21.*								
27	[a]The internal rate of return is computed by methods explained on pp. 737–738.								
28	[b]Present values from Table 2, Appendix B at the end of the book.								
29	[c]Sum is $(100) due to rounding. We round to $0.								
30	[d]Annuity present value from Table 4, Appendix B. The annuity table value of 3.791 is the sum of the individual discount rates								
31	0.909 + 0.826 + 0.751 + 0.683 + 0.621, subject to rounding.								

Appendix 2: Capital Budgeting and Inflation:

How to convert the discount rate (Required rate of return)

- Nominal interest rate=
  (1+Real interest rate)(1+Inflation)-1
  E.g.: (1+0.20)(1+0.10)-1 = (1.20)(1.10)-1 = 0.32 (i.e. 32%)

- Real interest rate =
  (1+Nominal interest rate)/(1+Inflation)-1
  E.g. (1+0.32)/(1+0.10)-1 = 0.20 (i.e. 20%)

Appendix 3: Simplified Free Cash Flow Model

Sales Revenues
Less: Variable costs
Less: Fixed outlays
Less: Depreciation
EBIT
Less: Taxes
Earnings after taxes
Plus: Depreciation
Less: Increase in Net working capital
Less: Capital expenditures
=FREE CASH FLOW

Appendix 4: Working Capital effects

Working capital change in calculations:

Ex 1: Initial WC requirement 500; Increase per period 100; No recovery at the end of useful life

EX 2: No increase in WC & + Recovery of the Initial Working capital at the end

EX 1	**Year 0** €000's	**Year 1** €000's	**Year 2** €000's	**Year 3** €000's
WC	500	600	700	800
CF effect	-500	-100	-100	-100

EX 2	**Year 0** €000's	**Year 1** €000's	**Year 2** €000's	**Year 3** €000's
WC	500	500	500	500 (0)
CF effect	-500	0	0	500

Appendix 5: Depreciation & Taxation

PANEL A: Two Methods Based on the Income Statement

C	Operating cash inflows from investment in machine	$120,000
D	Additional depreciation deduction	70,000
OI	Increase in operating income	50,000
T	Income taxes (Income tax rate $t \times OI$) = 40% × $50,000	20,000
NI	Increase in net income	$ 30,000
	Increase in cash flow from operations, net of income taxes	
	Method 1: $C - T$ = $120,000 − $20,000 = $100,000 or	
	Method 2: $NI + D$ = $30,000 + $70,000 = $100,000	

PANEL B: Item-by-Item Method

	Effect of cash operating flows	
C	Operating cash inflows from investment in machine	$120,000
$t \times C$	Deduct income tax cash outflow at 40%	48,000
$C - (t \times C)$ = $(1 - t) \times C$	After-tax cash flow from operations (excluding the depreciation effect)	72,000
	Effect of depreciation	
D	Additional depreciation deduction, $70,000	
$t \times D$	Income tax cash savings from additional depreciation deduction at 40% × $70,000	28,000
$(1 - t) \times C + (t \times D)$ = $C - (t \times C) + (t \times D)$	Cash flow from operations, net of income taxes	$100,000

Appendix 6: RRR for the Whole Company (Finland)

(Liljeblom and Vaihekoski, 2004)

QUESTION	%	N
What is your required rate of return for the whole company (WACC)		
< 0 %	0.0 %	0
0–5 %	0.0 %	0
5–10 %	11.6 %	5
10–12 %	23.3 %	10
12–14 %	2.3 %	1
14–16 %	27.9 %	12
16–18 %	4.7 %	2
18–20 %	9.3 %	4
>20 %	20.9 %	9
How often does it change?		
Never	15.0 %	6
Not every year	25.0 %	10
Once a year	60.0 %	24
More frequently	0.0 %	0
Is it the same for all projects, if project are equally long?		
Yes	22.2 %	10
In most cases	20.0 %	9
No, it can differ	57.8 %	26
Is it the same for investment projects of different lenghts?		
Higher for longer projects	3.4 %	1
Lower for longer projects	17.2 %	5
Same (length does not matter)	79.3 %	23
How is inflation handled in the calculation?		
Cash flows are real	15.2 %	7
Cash flows are nominal	84.8 %	39
Required rate of return is real	12.5 %	5
Required rate of return is nominal	87.5 %	35

Appendix 7: Project Cost of Capital (in Nordic countries) (Brunzell, Liljeblom, and Vaihekoski, 2013)

Use the WACC of the whole company also for different investment projects	29,4%
Adjust their WACC for project risk	26,1%
Adjust their WACC for the division's risk	3,3%
Adjust their WACC for country risk	5,2%

Appendix 8: Vuosaari Harbour: Making the sea route deeper

The summary of the profitability calculation (Ministry of Transport)

(Based on comparisons between alternatives 0 and 1)

VUOSAARI SEA ROUTE	Million euros	
Investment outlay		-32,2
Vessel cost savings	59,4	
Environmental impact	14,0	
Residual value	3,8	
Benefits (discounted)		77,2
Benefit less cost		**45,0**
Benefit Cost Ratio (77,2 / 32,2)		**2,4**