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DISTANCE LEARNING AND STUDY SUPPORTS OF DISTANCE EDUCATION

Practical demonstration of a seminar called 'Economic Evaluation of Public Projects of Investment Character' in the subject of 'Public Economics'

INTRODUCTION

Distance learning within the framework of a composite form of bachelor and master degree study programs has become trend at Czech universities recently. Distance learning is based, above all, on the students' individual work with special teaching texts, which are being developed for the purposes of distance education.

The personal contact between the student and the tutor is very limited. There are only three one-hour consultations (initial, running and final) during the course of a term. The communication between the tutor and the student is based, above all, on communication by e-mail. And that is why the study support of distance education is, from both the content and formal points of view, of a specific form. For this purpose, they are created in the way to show the information in a clear and concentrated form. Moreover, the tutor acts within the framework of the entire study material as the student's guide in the form of advice, remarks and comments.

And how are these study texts drawn up? Each chapter starts with setting up an objective that the students should meet - it says clearly what the students should know after they have studied the given chapter. A study guide that explains how the students should work follows. Then, the attention is paid to the curriculum itself. It is rich in the quantity of practical examples enabling better understanding and remembering of acquired information. Each chapter is closed with a summary and a list of terms to learn. There are also revisory questions to check how the students have mastered the given problems. Other checking components of the texts are tests with a key. The very end of each chapter brings a list of used literature, which can be used if the student would like to study the given problems in more detail.

The authors of this kind of study books pay special attention to the graphic aspect. The study texts are, for example, supplemented with pictographs and marginal comments. For pictographs used by Faculty of Economics and Administration, the University of Pardubice, see the table.

Table 1. List of Pictographs

	Guide of Study
	Example
!	**Concept Question**
	Correspondence Task
Σ	**Summary and Conclusions**
?	**Comprehension Check**
	List of Terms
	Self-Test
☑	**Answers to Self-Test**
	Literature

The study support texts for distance education are drawn up both as textbooks and as workbooks. The study support - workbooks usually contain just some of the above distance components.

The following part presents a concrete demonstration of a seminar in the subject of 'Public Economics', the topic of which being 'Economic Evaluation of Public Projects of Investment Character'. The subject of 'Public Economics' is taught at Faculty of Economics and Administration, the University of Pardubice, in the second year of a composite form of bachelor study programs called 'Economy Politics and Administration' and 'System Engineering and Information Science'.

ECONOMIC EVALUATION OF PUBLIC PROJECTS OF INVESTMENT CHARACTER

Objectives:

After studying this chapter, you should have a good understanding of:

⇒ how to determine the present value of multiple (irregular) and annuity cash flow;

⇒ how to evaluate investment public project using net present value of benefits, benefit-cost ratio and internal rate of return;

⇒ how to explain relationships among net present value of benefits, benefit-cost ratio and internal rate of return.

Guide of Study:

Now you will solve a set of examples that will help you to acquire the methods of evaluation of public projects with investment character. Attention is paid to the most important criteria of evaluation of investment public projects - net present value of benefits, benefit-cost ratio and internal rate of return. The relationships among these criteria are also explained.

Good luck during your study!

PRESENT VALUE AND DISCOUNTING

In case that the costs and benefits of projects are created during a longer time period (longer than one year) - in case of investment projects, it is necessary to respect time value of money.

In the most general sense, the phrase time value of money refers to the fact that an EUR in hand today is worth more than an EUR promised at some time in future.

To guarantee comparability of all costs and benefits, its necessary to calculate the present value of a future cash flow of costs and benefits and determine their today value.

Concept Question
Do you remember what you learned about the calculation of the present value in „Financial Mathematics“? How is it possible to calculate the present value of a cash flow?

Present value = future value * present value factor
present value factor (discount factor) = 1/(1 + i)^n, where
i ... discount rate (interest rate),
n ... number of years (number of periods).

$$\textbf{Present value of multiple irregular cash flow} = \sum_{t=1}^{n} \frac{CF_t}{(1+i)^t}$$

, where

CF_t ... cash flow in single years,
i ..... discount (interest) rate,
t ..... single years,
n ..... total number of years.

Present value of annuity cash flow - we can calculate present value of annuity cash flow not only with present value factor but also with annuity present value factor.

Present value of annuity cash flow = annuity * annuity present value factor

$$\textbf{Present value of annuity cash flow} = \textbf{anuity} * \frac{1 - \frac{1}{(1+i)^n}}{i}$$

, where

i ... discount (interest) rate,
n ... total number of years.

EXAMPLE 1

Problem
Calculate present value of the following annuity cash flow, where discount rate is 7 %. Calculate using present value factor and annuity present value factor and then compare the results.

Period	Cash flow in EUR
1st year	1,200,00
2nd year	1,200,00
3rd year	1,200,00

Complete the following claims:

a) Present value of the cash flow calculated using present value factor is equal to ..... EUR.
b) Present value of the cash flow calculated using annuity present value factor is equal to ..... EUR.
c) Present value of the cash flow calculated using present value factor is ..... (higher than, lower than, equal to) present value of the cash flow calculated using annuity present value factor.

Solution

a) Present value of the cash flow calculated using present value factor

Period	Cash flow in EUR	i = 7 %	PV of cash flow
1st year	1,200,0	1,200,000 * 0.	1,122,00
2nd year	1,200,0	1,200,000 * 0.	1,047,60
3rd year	1,200,0	1,200,000 * 0.	979,200
Total			**3,148,80**

Present value of the cash flow calculated using present value factor is equal to **3,148,800** EUR.

b) Present value of the cash flow calculated using annuity present value factor

Present value of annuity cash flow = annuity * annuity present value factor

PVA = annuity * APVF

$$PVA = anuity * \frac{1 - \frac{1}{(1+i)^n}}{i}$$

PVA = 1,200,000 * APVF (7 %, 3 years) = 1,200,000 * 2.624 = **3,148,800**
Present value of the cash flow calculated using annuity present value factor is equal to **3,148,800** EUR.

c) Present value of the cash flow calculated using present value factor is **equal to** present value of the cash flow calculated using annuity present value factor.

RULES OF EVALUATION OF INVESTMENT PROJECTS

In case of evaluation of investment public projects when it is necessary to respect time value of money, we can use the following criteria:

- net present value of benefits;
- benefit-cost ratio;
- internal rate of return.

Net Present Value of Benefits and Benefit-Cost Ratio

Net present value of benefits (NPV) represents the difference between the present value of benefits and costs. The project is acceptable if net present value of benefits is ≥ 0. The project with the highest net present value of benefits is the most favorable.

$$\text{Net present value of benefits} = \sum_{t=1}^{n} (B_t - C_t) * (1+i)^{-t}$$

, where

B_t ... benefits of the project in single years,
C_t ... costs of the project in single years,
i .... discount rate,
t .... single years,
n .... total number of years.

Benefit-cost ratio (BCR) - the project is acceptable if benefit cost ratio is ≥ 1. The project with the highest benefit cost ratio is the most favorable.

$$\text{Benefit-cost ratio} = \frac{\sum_{t=1}^{n} B_t (1+i)^{-t}}{\sum_{t=1}^{n} C_t (1+i)^{-t}}$$

, where

B_t ... benefits of the project in single years,
C_t ... costs of the project in single years,
i .... discount rate,
t .... single years,
n .... total number of years.

EXAMPLE 2

Problem

Compare the following projects.

C		Capital costs (EUR)
		150,000
	Benefits (EUR)	Operating costs (EUR)
1st year	20,00	100,00
2nd year	20,00	100,00
3rd year	300,00	100,00
4th year	300,00	100,00

D		Capital costs (EUR)
		150,000
	Benefits (EUR)	Operating costs (EUR)
1st year	0	0
2nd year	0	0
3rd year	200,0	100,00
4th year	200,0	100,00

Set:

a) Net present value of benefits of project C, if the discount rate is 8 %.
b) Benefit cost ratio of project C, if the discount rate is 8 %.
c) Whether project C is acceptable, if the discount rate is 8 %.
d) Net present value of benefits of project D if the discount rate is 8 %.
e) Benefit cost ratio of project D, if the discount rate is 8 %.
f) Whether project D is acceptable, if the discount rate is 8 %.
g) Which of these projects is more advantageous?

Solution

Project C	Cash flow	APVF/ PVF i = 8 %	PV of cash flow
Capital costs	150,00		150,000
Operating costs - 1st year	100,00		
Operating costs - 2nd year	100,00		
Operating costs - 3rd year	100,00		
Operating costs - 4th year	100,00		
PV of total operating costs		3.312	331,200
PV of total costs			481,200
Benefits - 1st year	20,00	0.926	18,520
Benefits - 2nd year	20,00	0.857	17,140
Benefits - 3rd year	300,00	0.794	238,200
Benefits - 4th year	300,00	0.735	220,500
PV of benefits			494,360
Net present value			**1.027**
Benefit-cost ratio			**13,160**

Project D	Cash flow	PV i = 8 %	PV of cash flow
Capital costs	150,00		150,000
Operating costs - 1st year	0		0
Operating costs - 2nd year	0		0
Operating costs - 3rd year	100,00	0.794	79,400
Operating costs - 4th year	100,00	0.735	73,500
PV of total operating costs			152,900
PV of total costs			302,900
Benefits - 1st year	0		0
Benefits - 2nd year	0		0
Benefits - 3rd year	200,00	0.794	158,800
Benefits - 4th year	200,00	0.735	147,000
PV of benefits			305,800
Net present value			**1.010**
Benefit-cost ratio			**2,900**

a) Net present value of benefits of project C is equal to 13,160 EUR.
b) Benefit cost ratio of project C is equal to 1.027.
c) YES, project C is acceptable.
d) Net present value of benefits of project D is equal to 2,900 EUR.
e) Benefit cost ratio of project D is equal to 1.010.
f) YES, project D is acceptable.
g) Project C is more advantageous.

Internal Rate of Return

Internal rate of return (IRR) calls for determining the yield on an investment, that is, calculating the discount rate that equates the cash outflows (costs) of an investment with the subsequent cash inflows (benefits). The final selection of any project under the internal rate of return method will depend on the yield exceeding some minimum level, such as required discount (interest) rate. The project is acceptable if the internal rate of return is higher than the required interest rate and then the most advantageous project is the project with the highest internal rate of return.

$$\sum_{t=1}^{n} (B_t - C_t) * (1 + r)^{-t} = 0$$

, where

B_t ... benefits of the project in single years,
C_t ... costs of the project in single years,
r ... internal rate of return,
t .... single years,
n .... total number of years.

To find an internal rate of return we can use **interpolation**. Since the internal rate of return is determined when the present value of the inflows (benefits) equals the present value of the outflows (costs), we need to find a discount rate that equates the present value of the benefits with the present value of the costs.

We can use the following formula:

$$IRR = i_L + \frac{NPV_L}{NPV_L + |NPV_H|} + (i_H - i_L)$$

,where

IRR ..... internal rate of return,
NPV_L ... net present value of benefits for lower interest rate,
NPV_H ... net present value of benefits for higher interest rate,
i_L ... lower selected interest rate (which will guarantee positive NPV),
i_H ... higher selected interest rate (which will guarantee negative NPV).

EXAMPLE 3

Problem

Calculate internal rate of return of project D (see example 2) and decide whether the project is acceptable. Required interest rate is 6 %.

Solution

$$IRR = i_L + \frac{NPV_L}{NPV_L + |NPV_H|} + (i_H - i_L)$$

If i = 8 %, then NPV = 2,900 EUR $\Rightarrow i_L = 8$ % and $NPV_L = 2{,}900$ EUR.
If i = 9 %, then NPV = - 2,000 EUR $\Rightarrow i_H = 9$ % and $NPV_H = -2{,}000$ EUR.

$$IRR = 8 + \frac{2{,}900}{2{,}900 + |-2{,}000|} + (9 - 8)$$

IRR = 8.6 %

Internal rate of return is equal to 8.6 %. The project is acceptable if the required interest rate is equal to 6 % (8.6 % > 6 %).

Relationships among Net Present Value of Benefits, Benefit-Cost Ratio and Internal Rate of Return

During the process of evaluation of investment public project it is necessary to take into consideration the following facts:

- if the net present value of benefits is positive (> 0), then the benefit-cost ratio is > 1;
- if the net present value of benefits is equal to 0, then the benefit-cost ratio is equal to 1;
- if the net present value of benefits is negative (< 0), then the benefit-cost ratio is < 1;
- internal rate of return is a rate where net present value of benefits is equal to zero.

EXAMPLE 4

Problem

Select the most advantageous public project from the following projects:

a) project A - if the interest rate is 8 %, net present value of benefits of this project is equal to minus 125,000 EUR;
b) project B - the internal rate of this project is equal to 8.5 %;
c) project C - if the interest rate is 8.5 %, benefit-cost ratio of this project is equal to 1.1;
d) project D - if the interest rate is 8 %, net present value of benefits of this project is equal to 0.

All these projects are connected with capital cost in amount of 500,000 EUR.

Solution

The most advantageous project is **project C** because:

- project A - if the interest rate is 8 %, NPV = - 125,000 EUR, then the project is not acceptable;
- project B - IRR = 8.5 %, so that if the interest rate is 8.5 %, then NPV = 0 and BCR = 1;
- project C - if the interest rate is 8.5 %, BCR = 1.1, then at the interest rate 8.5 %, NPV > 0;
- project D - if the interest rate is 8 %, NPV = 0 (project D is worse than both project C and B).

LIST OF TERMS

Discounting
Discount rate
Net present value of benefits
Benefit-cost ratio
Internal rate of return

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