# Economic Value of Education Seminar 2 Rate of return to education: basic theory

The spreadsheets you need for this work are in the file called EVE S4 ROR1.xls.

## Investing in houses: comparing the costs and returns to an investment

In the human capital approach the return to investing in education is analogous to the return to investing in physical or financial capital. Here we will use the example of investing in a house that you intend to purchase and then rent. This example shows how the value of an asset today is calculated given assumptions about the future cash flows that the asset will yield.

You are considering purchasing a house to rent. The house costs £120,000 and you anticipate that after maintenance and other out-goings you will get £10,000 a year (assuming no inflation or that the calculations are in real terms) in rent for 20 years and then you will be able to sell the house for £200,000 at the end of the 20th year. The alternative is to invest the money in a bond on the stock market and get 10% a year rate of return.

You need to undertake an **investment appraisal**. This example will demonstrate the standard decision rule for deciding which assets will yield the highest rate of return.

To work out whether the house or the financial bond is the better investment you need to know the value to you today - the **present value** - of £10,000 in a year’s time, plus £10,000 in 2 years’ time plus £10,000 a year for a further 18 years plus £200,000 in 20 years’ time when the house is sold.

### Compound interest

To consider how to calculate the present value of £100 in 1 year’s or t years’ time, let’s start with its opposite – compound interest.

If you invest £100 at 10% for 1 year at the end of 1 year it will be worth:

100 \* (1+0.1) = 100 + 10 = 110.

If you invest the money for a further year and let the interest accumulate then after two years you will have:

110 \* (1+0.1) = 110 + 11 = 121

This is the same as:

100 \* (1+0.1) \* (1+0.1) = 100 \* (1+0.1)2

The general expression for the value of £1 after it has been invested for *t* years at a rate of interest of *r* is

**1(1+*r*)*t***

Where:

*r* = rate of interest expressed as a decimal

*t* = the number of years.

### Exercise 1

Using the compound interest table on the spreadsheet:

1. What would £100 be worth in 5 years’ time at an interest rate of 5%?
2. What would £100 be worth in 10 years’ time at an interest rate of 8%?
3. An investment advisor offers a guaranteed return of 6% over 5 years for investing in a bond with an upfront fee of £50, regardless of amount invested.
4. Is it worth investing £100 in this bond, compared to keeping the £100 under your bed?

### Present value of a sum of money

The present value of £*x* received in *t* years’ time is the amount of money that if invested now for *t* years at compound interest rate *r* would be equal to £*x* in *t* years time.

For example, £110 is received after 1 year. The rate of interest is 10%.

The present value of £110 received in 1 year’s time is £100 since £100 invested at 10% for one year will produce £110.

To calculate the net present value of £110 in 1 year we then need to do the reverse calculation to compound interest.

We divide £110 by (1+0.1), i.e. by 1.1, to get £100.

This is the same as dividing by (1+0.1)*t* = (1+0.1)1 since *t* = 1.

To calculate the present value of £121 in 2 years’ time when *r* = 0.1 we divide by

(1+0.1)2 = 1.21

**General expression for the present value**

The present value of a sum of money £*yt* received in *t* years’ time is:



If several amounts of money *yt* are received in different years 1, 2, 3 up to year *t* then the present value of this cash flow is:



This is written with a summation sign as:



### The rate of discount

The interest rate ‘*r*’ when used to calculate the present value of sum of money due to be received in the future is known as the rate of discount.

The procedure of calculating the present value of a future sum of money is known as discounting.

### Exercise 2

Use the present value table where each column shows the present value of £100 received in *t* years’ time (each row is a year) for the interest rates from 1% to 12%.

1. What is the present value of £100 received in 5 years’ time when r=5% (or 0.05)?
2. What is the present value of £100 received in 5 years’ time when r=1% (or 0.01)?
3. What is the present value of £100 received in 10 years’ time when r=10% (or 0.10)?
4. Given that the rate of discount is 10%, would you rather have £35.05 in 10 years’ time or £30 in 13 years’ time?

### Application of discounting to the house purchase investment decision

We will now return to the problem described on page 1 of whether it is worth purchasing the house if it costs £120,000 or whether a bond yielding 10% a year would be a better investment. The house will generate an income of £10,000 per year until it is sold after 20 years for £200,000.

### Exercise 3

1. Is it worth investing in the house when it costs £120,000 or is the bond the better investment?  
   To answer this you need to work out the present value of the sum of future net cash flows from the house over 20 years.

* Step 1: what is the present value of the sum of net income plus the sale value of the house? (You will find this on the spreadsheet – take a look at the formulae to make sure you understand them.)
* Step 2: what is the net present value of the house investment if it costs £120,000? In other words what is the difference between the present value of the cash flows from the house and what it costs to buy now?
* Step 3 (decision): does investing in the house give you a better financial return than investing your money in a bond which earns 10% pa?

1. Is it worth investing in the house when it costs £100,000 or is the bond the better investment?
2. Complete the criterion for an efficient investment decision:  
   A person will increase his/her wealth (and hence welfare or utility) if s/he purchases an asset (i.e. invests) for which the **net present value is greater than .**

# Some terms

### The discount rate

The discount rate is the rate of interest on borrowing money and is the opportunity cost of capital.

### The marginal rate of time preference

Resources are only available for investment (i.e. purchasing capital assets which will yield future streams of consumption and/or income) because some people are prepared to postpone current consumption and save.

People usually prefer consuming a given amount now than in the future (jam today is better than jam tomorrow). To give up consumption today they need to be compensated by the anticipation of more consumption in the future. This preference for X now relative to the future is known as **time preference**.

The rate at which a person is prepared to give up consumption today for more in the future and feel just as well off is the known as the marginal rate of time preference.

If an economy is in equilibrium then the marginal rate of time preference will equal the opportunity cost of capital and the desired amount of saving = the desired amount of investment.

### The internal rate of return

The internal rate of return is that rate of discount (or interest) which when used to discount an expected future stream of net cash flows over a period of t years (gross income minus costs) makes the net present value of net cash flows equal to zero.

The algebraic expression for the internal rate of return is:



Where

*Yt* = gross income in year *t*

*Ct* = cost in year *t*

(*Yt – Ct*) is summed over *T* years

*i* = internal rate of return

Provided that the net cash flows start negative and then become positive, the internal rate of return and net present value criteria yield the same decision rule regarding whether a particular investment option will increase a person’s (or society’s) wealth. (We will not go into exceptions to this rule.)

### Exercise 4

In the house purchase example you will find the IRR worked out for the two options in the spreadsheet (Ex4).

* When the house costs £120,000 to buy, the internal rate of return is 9.6%.
* When the house costs $100,000 to buy, the internal rate of return is 11.5%.

Compare the internal rates of return of the two house purchase options to the respective net present values of the expected future net income stream.

1. Delete less or greater as appropriate:
2. When the house costs £120,000 to buy, the NPV is less/greater than 0 and the IRR is less/greater than the rate of discount.
3. When the house costs £100,000 to buy, the NPV is less/greater than 0 and the IRR is less/greater than the rate of discount.
4. When is the IRR criterion for an efficient investment? Complete this statement:  
   A person will increase their wealth (hence welfare or utility) if they purchase an asset for which the internal rate of return exceeds the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

## Investing in education: the rate of return to education (algebraic method)

We will now apply the investment decision rule to investing in education. The method you are about to use is called the **algebraic** or **traditional** method. You should also note that in this example, only monetary returns and costs are included.

In order to estimate the net present value or the (private) internal rate of return of investing in education for an individual we need to forecast (if looking forward) or observe (if looking backwards) the private costs of education to the individual and the monetary returns in each year of their life.

### What to include as a private or social benefit or cost

If we are estimating the social rate of return to education we need to know the social costs of and social returns to the individual’s education.

* A private cost that is an opportunity cost to society is included in the total of social costs, whereas a private cost that is not a social opportunity cost is excluded from the total of social costs.
* Private returns include all disposable income (i.e. income after tax) received by the individual.
* Social returns include the value of output produced by the individual: in most estimates individuals’ earnings are assumed to reflect the value of the additional output attributable to the individual. (But this will not be the case if market imperfections distort wages so that they do not reflect the wage earner’s marginal product).
* A transfer payment is the transfer of resources from one individual to another and therefore does not represent either a social cost or a social benefit. Pensions, student grants, unemployment benefits and taxes are examples of transfer payments since they are money transferred between taxpayers, current savers or recipients of the transfers. Transfers do not represent an increase in national output – they are just a transfer of purchasing power between individuals. This affects the distribution of national output but not its total amount. Hence if education reduces unemployment benefit paid this is not a social benefit of education. But if education increases employment then the additional output is a social benefit.

### Opportunity cost

The opportunity cost of a good or service (like education) is the value of the resources used to produce that good. The value of these resources is the value of what they would have produced if allocated to the next most valued use.

* Only costs that are opportunity costs to individuals are included in the private costs of education.
* The social opportunity costs of education to society include the opportunity costs to the individual provided that they are not transfer payments.
* Items included in the private opportunity costs of education for the individual are not always those that are included in the social opportunity costs.
* For efficiency considerations economists consider only opportunity costs. Transfers are important for distributional and hence equity issues.

### Exercise 5

In the table indicate which are private or social opportunity costs, and which are private or social returns (benefits).

|  |  |  |
| --- | --- | --- |
| Type of cost or return | Private cost or return | Social cost or social return |
| Educational institutions’ marginal cost of providing education |  |  |
| Tuition fees paid by individuals |  |  |
| Costs of food, clothing, rent etc. of individual while in education |  |  |
| Maintenance grant |  |  |
| All out of pocket expenses on education paid by individuals for books, travel, ICT, etc. |  |  |
| Post-tax earnings foregone by individual due to enrolment in schooling, courses etc. |  |  |
| Taxes foregone by individual due to not working due to being educated |  |  |
| (Additional) Pre-tax earnings of the individual (after graduation) |  |  |
| (Additional) Post-tax earnings of the individual (after graduation) |  |  |
| Tax revenue from spending done by individual |  |  |
| Higher pension due to employer and personal pension schemes |  |  |

### Calculating the rate of return to an individual’s education: algebraic method

The spreadsheet (Ex6) shows a worked example of the algebraic (traditional) method of calculating the private and social rates of return to education (only monetary returns and costs are included) for an individual. It shows the projected costs of educating ‘Chris’ from the age of 5. Chris will attend university and graduate after 3 years at the age of 21. Chris will continue uninterrupted in full time employment until retirement at 65 and die at 70. His/her earnings and pension are shown before and after tax.

The final column of figures shows the internal rate of return from Chris’s educational investment. Both the private and social internal rates of return are given. Remember that these are being calculated near the start of Chris’s life – at age 5. The chart shows the time profile of the costs and monetary income flows from the individual’s education over his/her lifetime.

### Exercise 6

1. What is included in:  
   (a) Chris’s net private returns?  
     
     
     
   (b) net social returns?
2. Why is Chris’s social rate of return to education less than his/her private rate?
3. Will the investment in Chris’s lifetime education, given the IRR, be socially efficient?
4. What has not been included in these calculations of Chris’s social rate of return to education?

### Calculating the rate of return (IRR) to education compared to the next lower level of education

Quite often rates of return to education are expressed as the return to a given level of education (e.g. a first degree or tertiary education) compared to the next lower level of education (e.g. upper secondary). This method is used a lot in OECD publications and in other studies. In the case of comparing tertiary to upper secondary education, the costs are those which are occurred in addition by the individual and by society when the individual takes a three year tertiary course rather than going into employment after completing upper secondary education. The gross and net income used in the IRR calculations are the differences between what the average person would have earned with only upper secondary education and what he/she earns with a university degree.

In the other comparison the costs included are those incurred additionally by undertaking upper secondary education and the returns are the difference in earnings between a person with lower secondary education only and one who completes upper secondary.

### Exercise 7

1. Why is the rate of return to upper secondary education compared to lower secondary education higher than the rate of return to tertiary education compared to upper secondary when people with tertiary education generally earn more than people with only upper secondary education?
2. Is investment in (i) tertiary education; (ii) upper secondary socially inefficient if the opportunity cost of capital is:  
   (a) 20%?  
     
   (b) 10%?  
     
   (c) 6%?
3. How do the following changes in assumptions affect the six IRRs (change them one at a time only)?  
   (a) a reduction in the tax rate to 25%?  
     
   (b) an increase in the annual cost of university provision by £2,500 per annum?  
     
   (c) tuition fee repayments in the form of a graduate tax of 4% until the age of 45?  
     
   (d) an increase in graduate earnings by 5% for each year of employment?