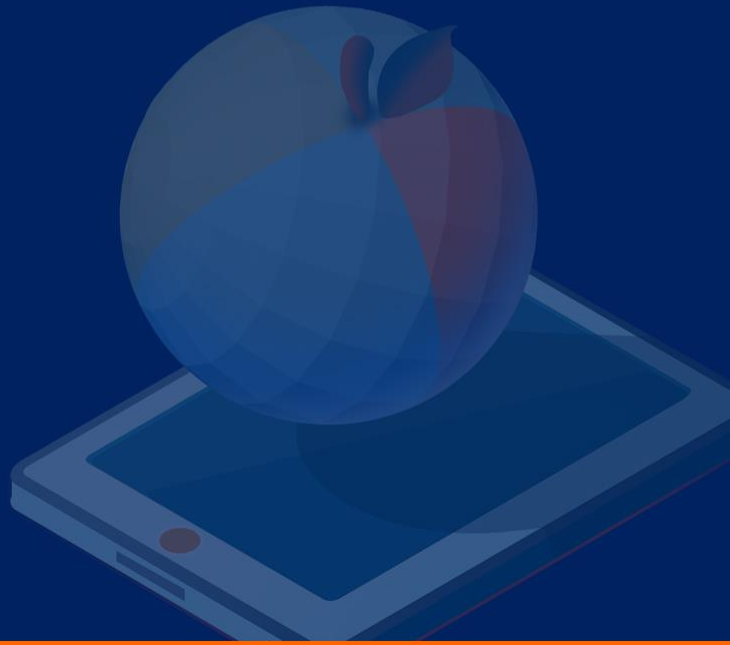
FINANCIAL EVALUATION AND STRATEGY:

CORPORATE FINANCE

with Heitor Almeida

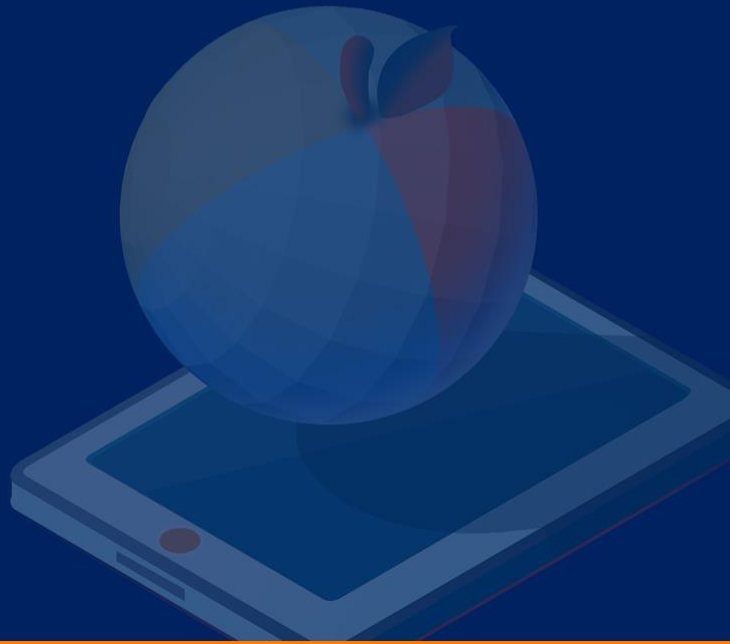


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-1

Objectives and Overview



HOW DO COMPANIES CREATE VALUE FOR SHAREHOLDERS?

(flickr.com/Images Money, 2011)

MAIN SOURCES OF VALUE CREATION – I

Creating new products

MAIN SOURCES OF VALUE CREATION – II

Buying other companies that have valuable projects

(Flazingo Photos, 2014)

CAN A FINANCE PROFESSOR CREATE AN I-PHONE?

(Experimenter Publishing, 1928)

NEW INVESTMENT AND SHAREHOLDER VALUE

What we can do is to try to figure out how much a new investment or acquisition will contribute to shareholder value!

MAKING INVESTMENT DECISIONS

We may even be able to stop a new cool product from being made …

(flickr.com/Images Money, 2011)

OUR MAIN GOAL

In the next two modules, we will learn how to estimate the contribution of a new project or a new acquisition to shareholder value.

Module 3: Making decisions about new projects

Module 4: Mergers and acquisitions

MODULE 3 OBJECTIVES

(1 OF 3)

You will learn:

- Why using net present value (NPV) is equivalent to maximizing shareholder value
- To build cash flows for NPV calculations
- How to compute NPV and how to use NPV to make decisions about projects
- The concept of internal rate of return (IRR) on a project

MODULE 3 OBJECTIVES

(2 OF 3)

You will learn:

- The relationship between NPV and the IRR
- How to compute IRR and how to use IRR to make decisions about projects
- Situations in which you should not use IRR to make investment decisions
- To incorporate real options into investment decisions using decision trees

MODULE 3 OBJECTIVES

(3 OF 3)

You will learn:

- How to make decisions about research and development (R&D) investments
- To value the option to wait and learn how to incorporate it into investment decisions
- How to incorporate an option to abandon into investment decisions

REFERENCE

Images Money. (2011). *Money from around the world* [Online image]. Retrieved August 31, 2015, from https://www.flickr.com/photos/59937401@N07/5856660723

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Images Money. (2011). *£1 dollar bill being cut in half* [Online image]. Retrieved August 31, 2015, from https://www.flickr.com/photos/59937401@N07/5857654560

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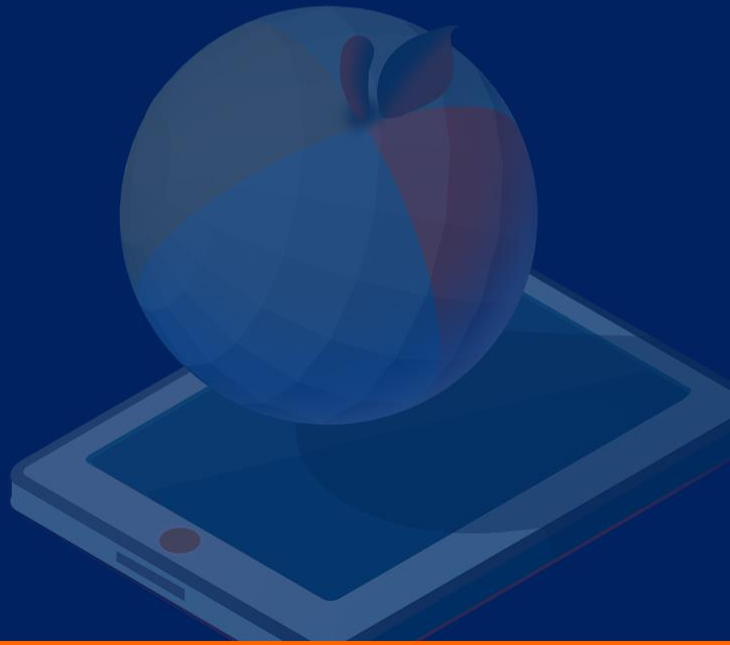
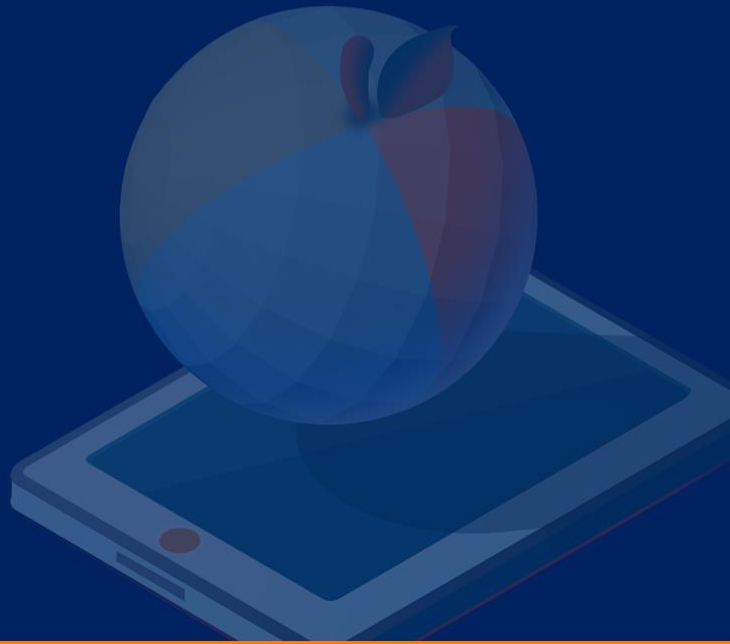


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-2

Example – Speeding Up the Collection of Receivables



COLLECTING RECEIVABLES

We worked on this problem in the final assignment of Module 2.

Expected annual sales = $1 billion
Currently 80% received immediately, 20% after one year
Firm can move to 90% immediate collection
But in that case firm expects revenue to go down 2%
Revenues are expected to remain constant

CASH FLOWS FOR BOTH COLLECTION SYSTEMS

	Today	Next year	Year after
Cash flow existing system	800	1000	1000
Cash flow new system	882	980	980

We derived these cash flows in the final assignment of Module 2.

INCREMENTAL CASH FLOWS

A key idea: the relevant cash flows to make the decision are incremental, or new minus old

minus

Left:(commons.wikimedia.org\Anthony22 ,2009) Right:(commons.wikimedia.org\Maasaak ,2014)

NEW MINUS OLD, RECEIVABLES EXAMPLE

	Today	Next year	Year after
Cash flow existing system	800	1000	1000
Cash flow new system	882	980	980
Incremental cash flow	+ 82	- 20	- 20

The new system looks attractive

But something is missing …

WHAT ABOUT FUTURE CASH FLOWS?

(flickr.com/Buck, 2009)

FUTURE YEARS

The same situation will repeat itself every year.

In the existing system, the firm sells 1,000, collects 800 immediately, and collects the receivables from last period (equal to 200).

With the new system, the firm sells 980, collects 882 immediately, and collects the receivables from last period (equal to 98).

INCREMENTAL CASH FLOWS OF THE NEW SYSTEM

	Today	Next year	Year after	Year after	…
Incremental cash flow	+ 82	- 20	- 20	- 20	…

We write these as a timeline.

WHAT SHOULD WE DO?

	0	1	2	3	
Incremental cash flows	82	-20	-20	-20	…

We can express the trade-off in numbers

Speeding up collection generates a cash flow of 82 million dollars today, but it reduces cash flows by 20 million dollars every year starting next year.

Is the benefit of receiving 82 million dollars today greater than the cost of losing 20 million dollars every year starting next year?

WE ARE MISSING SOMETHING …

(flickr.com/m01129, 2014)

To answer this question, we need to learn about net present value (NPV)!

REFERENCE

Anthony22. (2008). *Bright Red Car on Display at New York International Auto Show* [Online image]. Retrieved August 2, 2015, from https://commons.wikimedia.org/wiki/File:Bright_Red_Car_On_Display_At_New_York_International_Auto_Show.jpg

Maasaak. (2014). *Old Car and Old City* [Online image]. Retrieved August 2, 2015, from https://commons.wikimedia.org/wiki/File:Old_car_and_old_city.jpg

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m01129. (2014). *Thinking Man - Yale Museum of Art* [Online image]. Retrieved August 31, 2015, from https://www.flickr.com/photos/39908901@N06/13963173985

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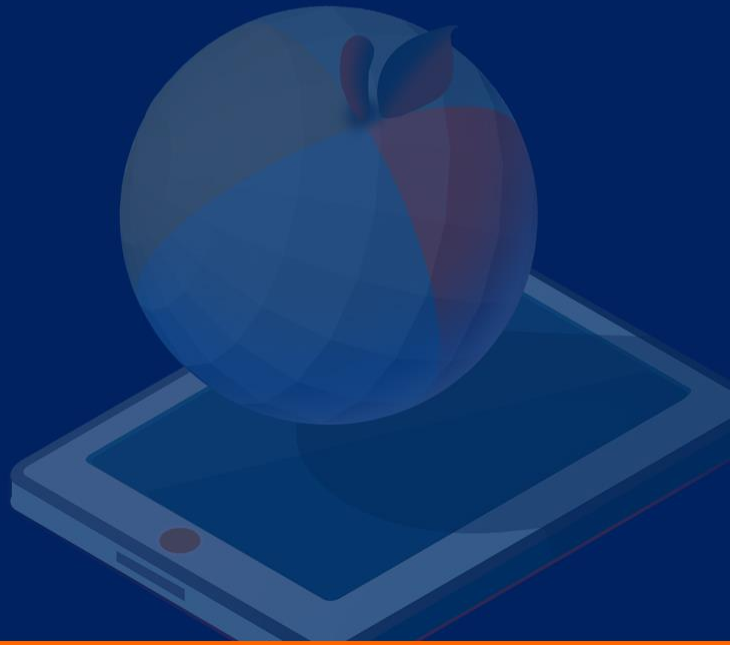
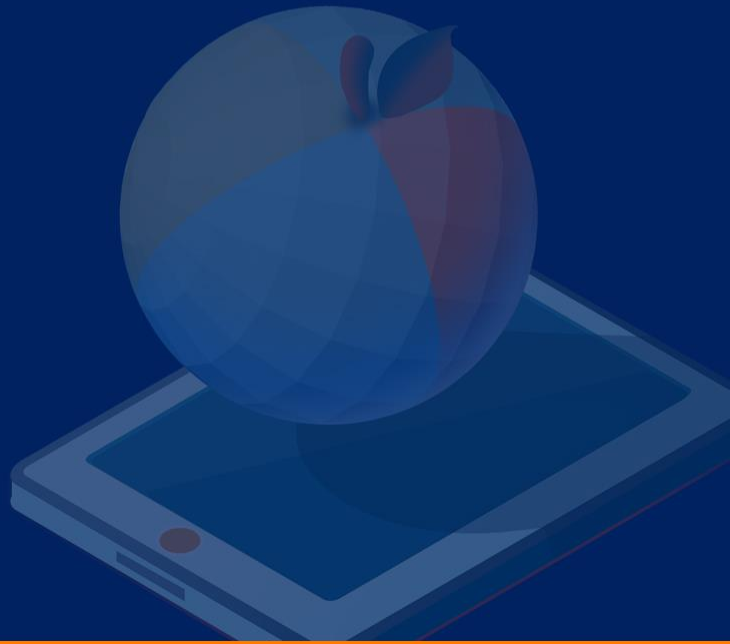


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-3

The Concept of Net Present Value (NPV)



NPV DEFINITION

NPV = sum of all incremental cash flows, discounted from the future to the current period

Take all incremental cash flows (e.g., new–old) into account

Discount to the current period

DISCOUNTING (PRESENT VALUE FORMULAS)

Notice the word “discounted” in the definition of NPV.

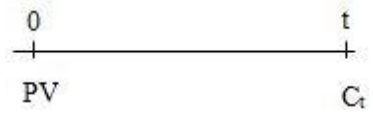
We need to know how to discount cash flows to the current period.

All you need are two formulas and a computer or a calculator!

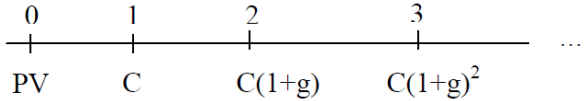
PRESENT VALUE FORMULAS

In all formulas, r is the discount rate.

1) $$PV = \frac{C_t}{(1+r)^t}$$



2) $$PV = \frac{C}{r-g}$$



Present value of growing perpetuity

All calculations can be done with these two formulas.

EXAMPLES

What is the present value of a 1 million dollar payment to be received in one year if the discount rate is 6% per year?

What is the present value of a stream of payments of 1 million dollars every year, lasting forever, if the discount rate is 6% a year?

(Maxwell, 2007)

SOLVED EXAMPLES

What is the present value of a 1 million dollar payment to be received in one year if the discount rate is 6% per year?

PV = 1,000,000 / (1 + 6%) = 943,396

What is the present value of a stream of payments of 1 million dollars every year, lasting forever, if the discount rate is 6% a year?

PV = 1,000,000 / (6% - 0%) = 16,666,667

Notice the growth rate is 0% in this case.

BACK TO THE ACCOUNTS RECEIVABLE EXAMPLE

	0	1	2	3	
Incremental cash flows	82	- 20	- 20	- 20	…

Speeding up collection generates a cash flow of 82 million dollars today, but it reduces cash flows by 20 million dollars every year starting next year.

To compute the NPV of the new collection system, we need to discount the stream of 20 million dollars cash flow per year back to the present.

How many years into the future should we consider?

INFINITE HORIZON

You will see that in most real-world relevant problems, the correct horizon to consider is infinity!

There is no “natural date” for a company to end.

If the company is sold to another buyer, for example, we need to figure out the sale price.

Sale price will depend on future cash flows after the sale!

INFINITE HORIZON – DISCOUNTING

But a cash flow that happens a thousand years in the future really shouldn't matter, right?

What is the present value of a payment of 1 billion dollars in 1,000 years if the discount rate is 6%?

PV = 1,000,000,000 / (1 + 6%)^(1,000) = 0.00000000000000049

SOLVING THE PROBLEM

	0	1	2	3	
Incremental cash flows	82	- 20	- 20	- 20	…

Suppose the company's discount rate is 10%.

What is the NPV of the new system?

NPV =

EXCEL EXERCISE

If the perpetuity formula still bothers you, do the following exercise:

Set the horizon to 30 years.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Incremental cash flows	82	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Incremental cash flows		- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20	- 20

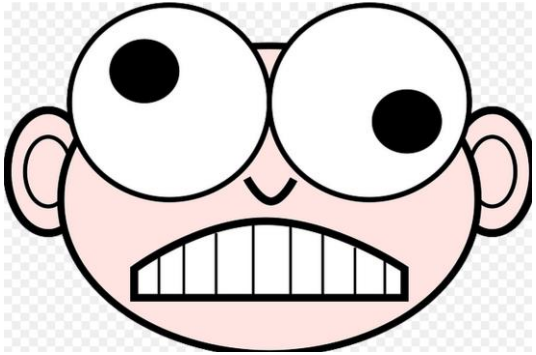
Compute the NPV in Excel.

Excel function: NPV = 82 + NPV (Discount Rate, Cell 1: Cell 30)

EXCEL, CONTINUED

This is the answer that I get:

NPV #########



If you open up the cell, this is what you get

NPV -10653.82893376600%

A LETTER FROM HEITOR

Dear Microsoft;

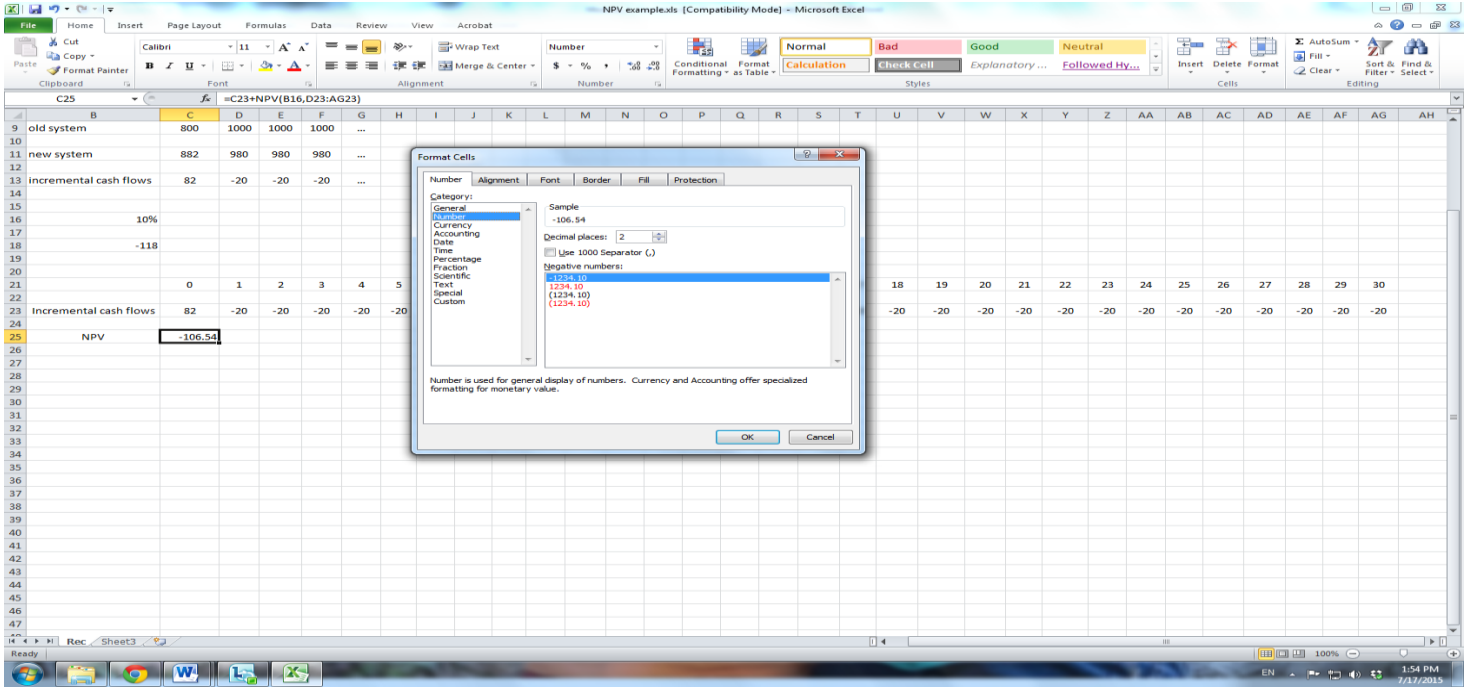
An NPV is not a percentage; it should be a number or a currency amount. And by the way, who needs twelve decimal points in a percentage number?

Yours truly,

Heitor

EXCEL ANSWER

You may need to format the answer



FINALLY – EXCEL ANSWER

Set the horizon to 30 years.

NPV = - 106.54

Our answer
NPV = - 118

What will happen if you increase the horizon to
50 years? NPV = -116.3
100 years? NPV = -117.99

Get the pattern?

REFERENCE

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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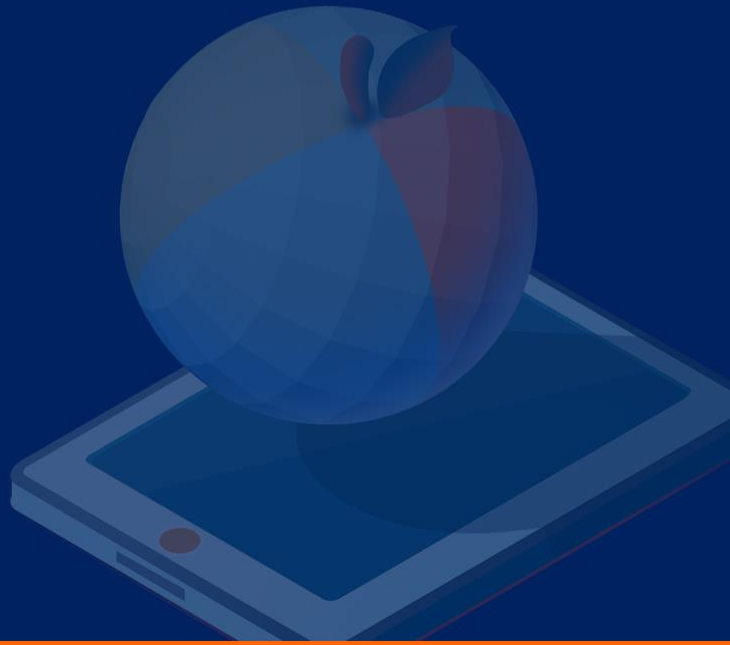
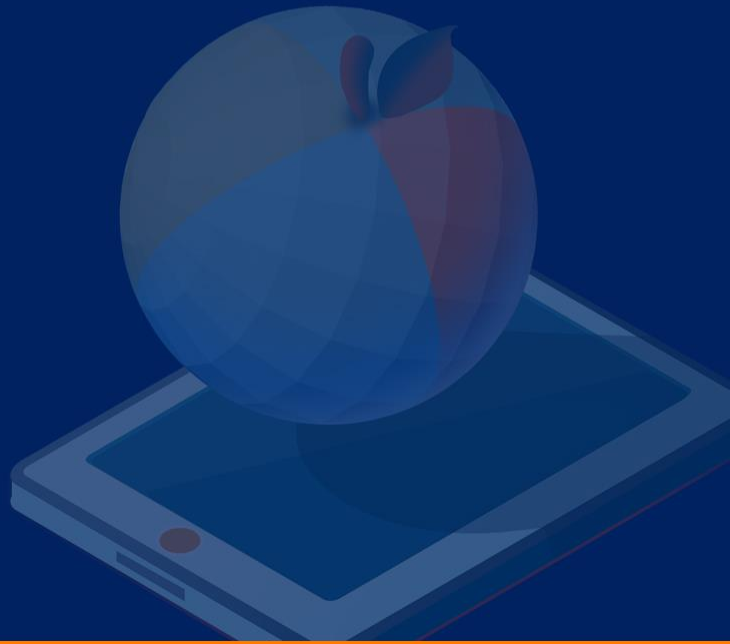


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-4

NPV and Shareholder Value



MAKING DECISIONS WITH NPV

Ok, you got an NPV of -118.

What should we do?

In order to understand this point, we need to discuss the relationship between NPV and shareholder value.

NPV AND STOCK PRICES

The stock price is the sum of all future cash profits, discounted to the current period (Module 1).

NPV = sum of all cash flows that are a direct consequence of taking a decision, discounted to the current period

These definitions are virtually the same!

ACCOUNTS RECEIVABLE EXAMPLE

	0	1	2	3	
Old system	800	1000	1000	1000	…
New system	882	980	980	980	…
Incremental cash flows	82	- 20	- 20	- 20	…

If the discount rate is 10%, what would happen to shareholder wealth if the company changes the system?

What should the company do?

(Maxwell, 2007)

ACCOUNTS RECEIVABLE EXAMPLE

	0	1	2	3	
Old system	800	1000	1000	1000	…
New system	882	980	980	980	…
Incremental cash flows	82	- 20	- 20	- 20	…

If the discount rate is 10%, what would happen to shareholder wealth if the company changes the system?

Down by 118M

What should the company do?

Keep the old system

EQUIVALENCE RESULT

The beauty of NPV – maximizing NPV is equivalent to maximizing shareholder wealth

> Thus, a financial manager that maximizes shareholder wealth should make decisions based on NPV.

Make all investments that have NPV > 0

THE ROLES OF INFORMATION, MARKET EFFICIENCY, AND LEVERAGE

In the real world, this equivalence will obviously not be perfect

Information: The market may not have perfect information about a company's new projects.

Efficiency: If markets are inefficient, then the stock price may not exactly reflect NPV even if there is perfect information.

Leverage: For companies close to bankruptcy, the cash flows from new projects may go to debtholders rather than shareholders (conflict). Capital structure topic, beyond the scope of this module

However, the result that NPV maximizes shareholder wealth is still a very useful guideline for financial management.

REFERENCE

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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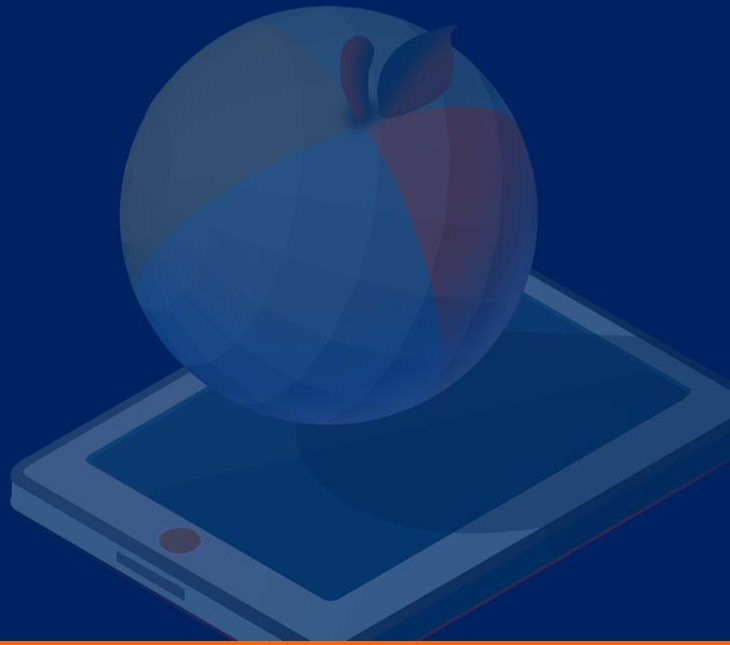
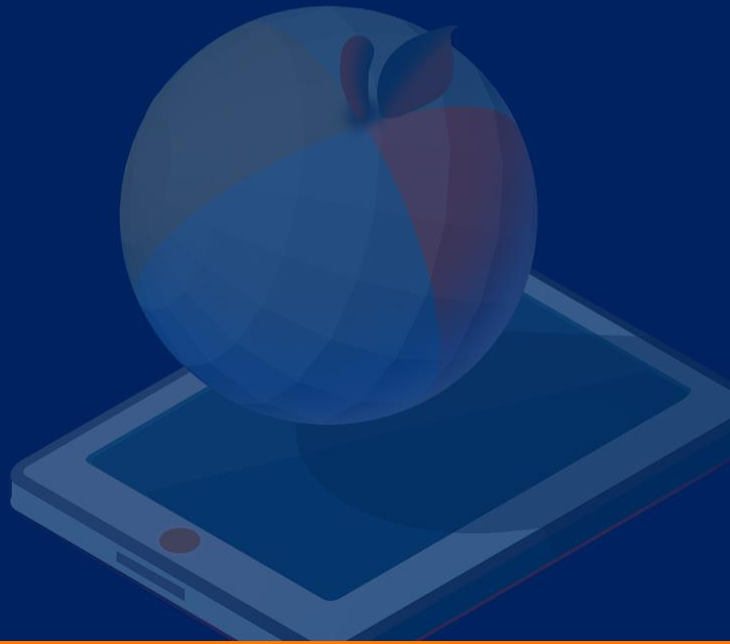


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-5

Internal Rate of Return (IRR)



DOLLARS VERSUS PERCENTAGES

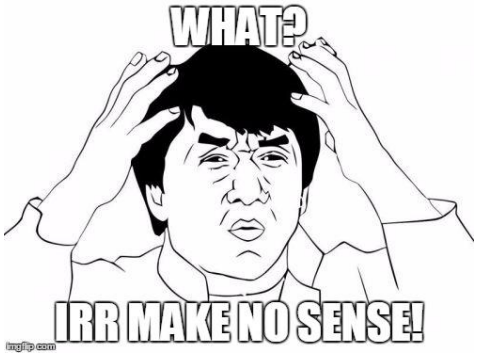
The NPV is a number in the same unit as the cash flows (e.g., dollars).

But we also (or mostly) think of investment returns in percentages (%).

DEFINITION OF IRR

The **IRR** is the rate of return of an investment.

The rate of return of an investment is the discount rate that makes the net present value (NPV) of an investment equal to zero.



Let us see why!

(imgflip.com/memegenerator/Jackie-Chan-WTF, 2015)

EXAMPLE – THE CONCEPT OF IRR

Suppose I offer you an investment that requires $10,000 today, and pays back $11,000 in a year's time. What is the rate of return on this investment?

What is the equation that you are solving in your brain?

GOING INSIDE THE BRAIN

(Ajifo,2014)

THIS IS WHAT I DISCOVERED INSIDE YOUR BRAIN

You were solving this equation:
(11,000 – 10,000) / 10,000 = 1,000 / 10,000 = 10%

Let us do some algebra
(11,000 – 10,000) / 10,000 = (11,000 / 10,000) - 1 = 10%
Or 11,000 / 10,000 = (1+10%)
Or 11,000 = (1 + 10%)* 10,000
Or 10,000 = 11,000 / (1 + 10%)

Finally
0 = 11,000 / (1 + 10%) - 10,000

The right hand side is the NPV of an investment of $10,000, that pays $11,000 in a year's time, when the discount rate is 10%

This NPV is equal to ZERO!

COMPUTING IRR

1. Write down the NPV

NPV = -10,000 + 11,000 / (1 + Discount rate)

2. Find the discount rate that makes the NPV equal to zero. This is the IRR.

In this case, IRR = 10%

COMPUTING IRR USING EXCEL

0	1
-10	11
IRR	10%

IRR = IRR (Cell 1, Cell 2)

ANOTHER EXAMPLE

Example: Investment requires $10,000 today, and produces a yearly cash flow of $500 in perpetuity. Cash flow is expected to grow at 4% a year.

What is the rate of return of this investment?

(Maxwell, 2007)

SETTING THE NPV TO ZERO

1. NPV = - 10,000 + 500 / (Discount rate - 4%)

2. - 10,000 + 500 / (IRR - 4%) = 0

IRR = 9%

This is the rate of return on this investment.

USING EXCEL

Can you use Excel in this case?

Problem: infinite cash flows!

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Incremental cash flows	-10000	500	520	540.8	562.4	584.9	608.3	632.7	658	684.3	711.66	740.1	769.7	800.5	832.5	865.8
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Incremental cash flows		900.47	936.5	973.95	1012.9	1053.4	1096	1139.4	1185	1232	1282	1332.9	1386.2	1442	1499	1559

Bad approximation – IRR = 6.65%

REFERENCE

Ajifo, A. (2014). *Synapse* [Online image]. Retrieved August 3, 2015, from https://www.flickr.com/photos/125992663@N02/14414381350/

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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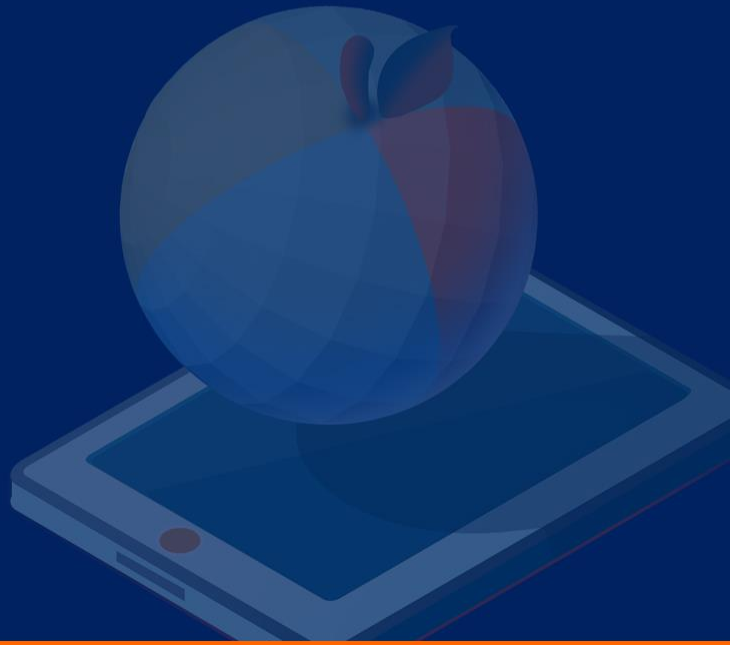
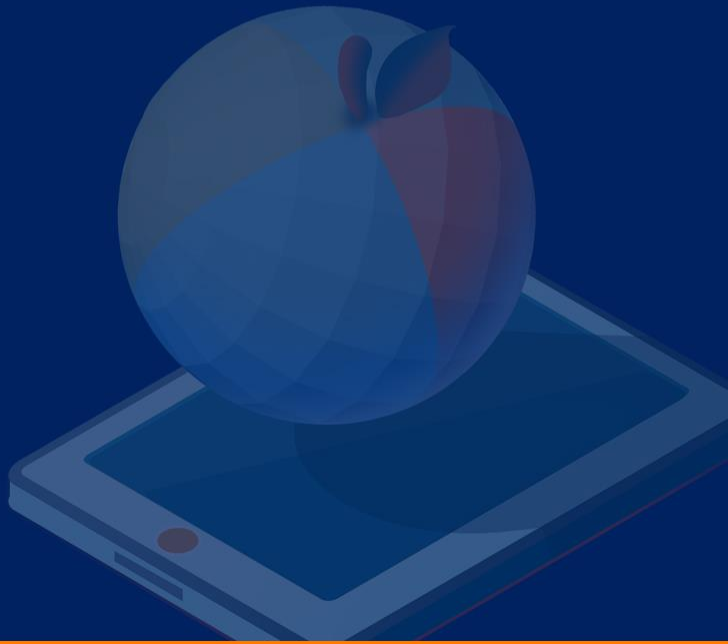


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-6

Using the IRR to Evaluate the Investments



USING THE IRR TO MAKE PROJECT DECISIONS

Investment requires $10,000 today, and produces a yearly cash flow of $500 in perpetuity. Cash flow is expected to grow at 4% a year.

IRR = 9%

Should we invest in this project?

THE IRR RULE

Invest in a project if its IRR is greater than the discount rate.

In our case, we would invest in the project if the discount rate is lower than 9%.

Discount rate is the required return on a project.

Actual return > required return

IRR AND NPV – EXAMPLE

(1 OF 3)

Investment requires $10,000 today, and produces a yearly cash flow of $500 in perpetuity. Cash flow is expected to grow at 4% a year.

IRR = 9%

What is the NPV of this investment when the discount rate is **8%?**

IRR AND NPV – EXAMPLE

(2 OF 3)

Investment requires $10,000 today, and produces a yearly cash flow of $500 in perpetuity. Cash flow is expected to grow at 4% a year.

IRR = 9%

What is the NPV of this investment when the discount rate is **10%?**

IRR AND NPV – EXAMPLE (3 OF 3)

IRR = 9%

If discount rate is 8%, NPV = 2,500

If discount rate is 10%, NPV = -1,667

What did you learn?

(Maxwell, 2007)

IRR AND NPV

NPV > 0 if the IRR is bigger than the discount rate

NPV < 0 if the IRR is lower than the discount rate

So a financial manager who makes decisions based on IRR/discount rate comparison will typically "get it right"

You can use either NPV or IRR in most cases

REFERENCE

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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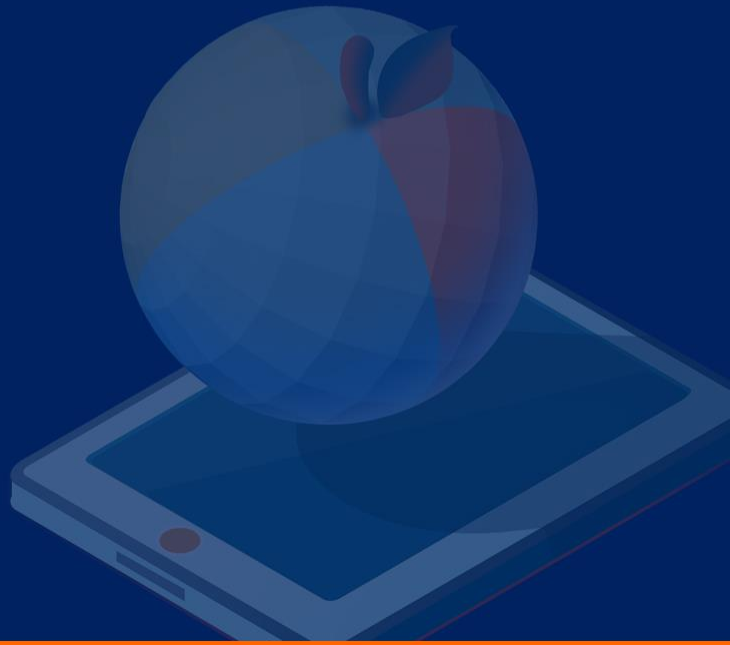
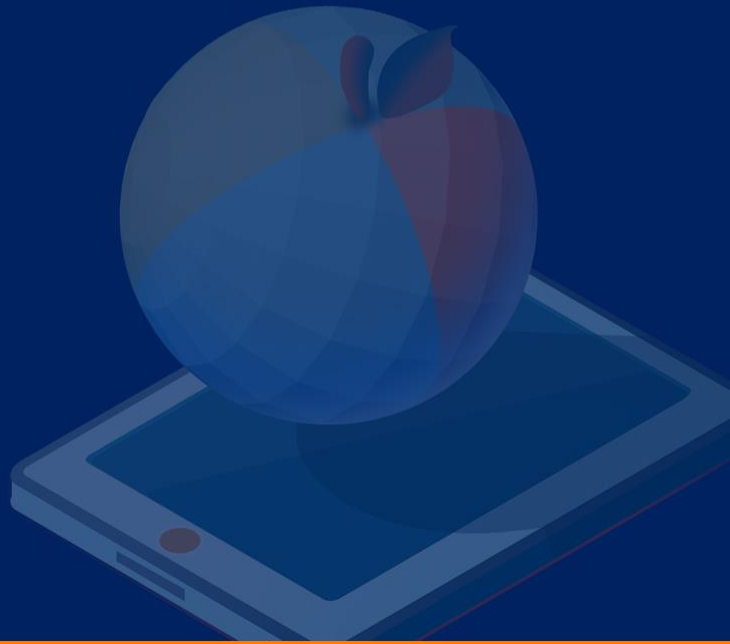


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-7

Problems with the IRR



WHEN IRR FAILS

Before you jump to the conclusion that IRR and NPV are always equivalent, let us learn some problems with the IRR.

(Paterson,2007)

EXAMPLE 1

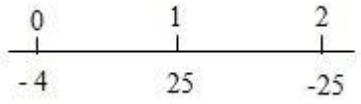
Some investments do not have a well-defined rate of return.

It sounds like it is -10%?

But try to use Excel

0	1
20	-22
IRR	10%

EXAMPLE 2



Using Excel:

0	1	3
-4	25	-25
IRR	25.00%	

But ... $$-4+\frac{25}{(1+400\%)}-\frac{25}{(1+400\%)^2}=0$$

so 400% is also an IRR?

WHAT IS THE COMMON FEATURE OF EXAMPLE 1 AND EXAMPLE 2?

Negative cash flow after a positive one!

If you see this pattern, don’t use IRR!

UNITS AND MAGNITUDES

NPV is in the same unit as the cash flows (e.g., dollars). The higher the NPV, the greater the impact of a project on shareholder value

IRR is a percentage return. This can create problems.

EXAMPLE 3 (1 OF 3)

Investment 1 requires one cent today and pays off two cents next year.

Investment 2 requires 100 dollars today and pays off 200 dollars next year.

What are the rates of return?

IRR 1 = 100%

IRR 2 = 100%

EXAMPLE 3 (2 OF 3)

Suppose the discount rate is 10%

Which investments would you take?

Which is the better investment?

Which investment has the greater NPV?

(Maxwell, 2007)

EXAMPLE 3 (3 OF 3)

Suppose the discount rate is 10%

Which investments would you take?

Both!

Which is the better investment?

Investment 2

Which investment has the greater NPV?

Investment 2

THREE RULES TO REMEMBER (1 OF 3)

1. IRR and NPV lead to identical decisions in most cases.

NPV > 0 if and only if IRR > Discount rate

THREE RULES TO REMEMBER (2 OF 3)

2. Don’t try to use IRR if you see a negative cash flow showing up after a positive one.

For example, our original accounts receivable problem!

THREE RULES TO REMEMBER (3 OF 3)

3. Beware of magnitudes.

Don’t use IRR to compare investments of different sizes.

REFERENCE

Paterson, I. (2007). *“Slow Down, Me Duck!”* [Online image]. Retrieved August 3, 2015, from http://www.geograph.org.uk/photo/521198

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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CORPORATE FINANCE

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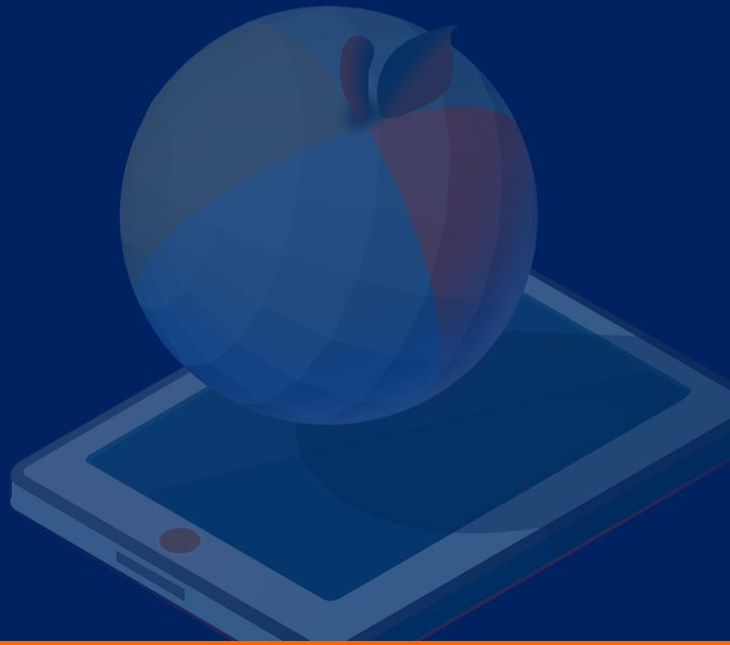
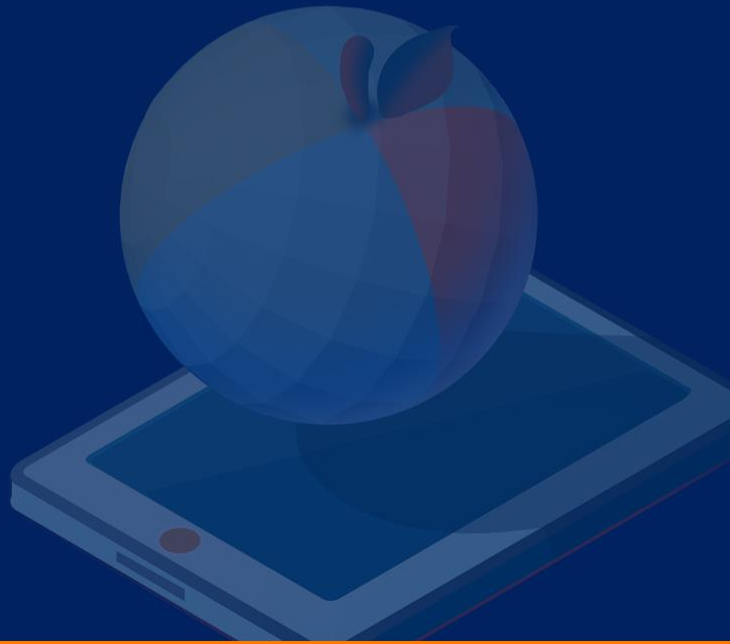


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-8

Additional Examples



PRACTICE MAKES PERFECT

Let us solve a few more examples together.

(commons.wikimedia.org/Jonik, 2004)

EXAMPLE 1 – PROJECT VALUATION

You are considering a project with the following characteristics:

- $40,000 initial investment
- $12,000 added cash revenue per year
- $3,000 added cash expenses per year
- Added depreciation of $8,000 per year for 5 years
- Investment lasts 10 years
- Marginal tax rate is 30%
- Salvage value at end of 10 years is $4,000 (before tax)
- Discount rate is 8%

Let us find out the NPV and IRR of this project.

STEP 1 – BUILD CASH FLOWS

0 (now)	-40,000			
1 - 5	+ 12,000	Added revenue	6 - 10	+ 12,000
	- 3,000	Added expenses		- 3,000
	= 9,000	Before depreciation		= 9,000
	- 8,000	Depreciation		- 0
	= 1,000	Taxable income		= 9,000
	x 30%	Tax rate		30%
	= 300	Taxes paid		= 2,700
	= 700	After-tax income		6,300
	+ 8,000	Depreciation		0
	= 8,700	CASH FLOW		6,300
Salvage Yr 10	4,000 - (4,000* .30) =2,800			

DEPRECIATION TAX SHIELD

Depreciation is tax deductible (cost), but it is a non-cash expense.

So we deduct depreciation to compute taxes and then add it back to the cash flows.

To check whether you understood this, ask yourself: why is the cash flow higher in years 5-10?

STEP 2 – CALCULATE NPV

NPV = - 40,000 + 8,700 /(1 + 8%) + 8,700 / (1+8%)^2 +…
+ 8,700 (1+8%)^5 + 6,300/(1+8%)^6+…
+6,300/(1+8%)^10 + 2,800 /(1+8%)^10

=13,152

Or use Excel

Cash flows										
0	1	2	3	4	5	6	7	8	9	10
-40000	8700	8700	8700	8700	8700	6300	6300	6300	6300	9100
NPV	$13,152.96									

COMPUTE IRR (1 OF 2)

Check your understanding!

1. Can you compute IRR in this case?

2. Before you compute the IRR, can you guess a range for what it should be?

(Maxwell, 2007)

COMPUTE IRR (2 OF 2)

Check your understanding!

1. Can you compute IRR in this case?

Yes – standard cash flows

2. Can you guess a range for what it should be?

IRR > 8%

COMPUTE IRR

Using Excel

Cash flows										
0	1	2	3	4	5	6	7	8	9	10
-40000	8700	8700	8700	8700	8700	6300	6300	6300	6300	9100
NPV	$13,152.96									
IRR	15.25%									

EXAMPLE 2 – INCREMENTAL CASH FLOWS (1 OF 4)

A company is considering an investment in a machine that has the following cash flows. There are no taxes.

Time	A
0 (2010)	- $70,000
1 (2011)	+ 25,000
2 (2012)	+ 25,000
3 (2013)	+ 25,000
4 (2014)	+ 25,000

EXAMPLE 2 – INCREMENTAL CASH FLOWS (2 OF 4)

The company uses an 8% discount rate. The machine will be discontinued in 2014 and has zero salvage value.

Time	A
0 (2010)	- $70,000
1 (2011)	+ 25,000
2 (2012)	+ 25,000
3 (2013)	+ 25,000
4 (2014)	+ 25,000

Compute the net present value of the investment as of 2010.

NPV = 12,800

EXAMPLE 2 – INCREMENTAL CASH FLOWS (3 OF 4)

In 2011 (after the 2011 cash flow is produced), a new and better machine becomes available that will reduce costs and thereby increase cash flows until it is discontinued in 2014 (zero salvage value).

Time	B
0 (2011)	- 90,000
1 (2012)	+ 45,000
2 (2013)	+ 45,000
3 (2014)	+ 45,000

EXAMPLE 2 – INCREMENTAL CASH FLOWS (4 OF 4)

The old machine has been depreciated to $50,000 and could be sold in 2014 for $39,000.

Should we sell the old machine and replace it with the new machine?

FINDING CASH FLOWS

Remember the key idea:
Incremental = New – Old

Which cash flows are a direct consequence of replacing the machine?

SUNK COSTS AND IRRELEVANT INFORMATION

Does the initial investment of $70,000 in the old machine matter for the decision?

No – no matter what you do, the $70,000 are “sunk”

Does the depreciation of the old machine matter?

No – there are no taxes

FINDING INCREMENTAL CASH FLOWS (1 OF 2)

2011

Old: keep the old machine (0 cash flow)

New: sell the old machine for $39,000, and buy the new one for $90,000

Incremental cash flow =

2012 to 2014

Old: cash flow = 25,000
New: cash flow = 45,000

Incremental cash flow =

(Maxwell, 2007)

FINDING INCREMENTAL CASH FLOWS (2 OF 2)

2011

Old: keep the old machine (0 cash flow)

New: sell the old machine for $39,000, and buy the new one for $90,000

Incremental cash flow **= -51,000**

2012 to 2014

Old: cash flow = 25,000
New: cash flow = 45,000

Incremental cash flow **= 20,000**

FIND THE NPV

Now it should be easy!

	2011	2012	2013	2014
Incremental cash flows	- 51000	20000	20000	20000
NPV	541.94			

NPV = 541.94 dollars

Should we replace the machine?

WHAT SHOULD WE DO?

A small positive NPV

The answer is yes – we should replace the machine.

But the small NPV gives us reason to think. Are we really sure about our numbers?

In Module 4, we will think about uncertainty in investment decisions.

EXAMPLE 3 – OPPORTUNITY COSTS

A real estate developer is considering whether to build a mall in a piece of land they already own.

Construction costs are going to run at 20 million dollars, and the mall can produce rental income whose present value is estimated to be equal to 25 million dollars.

Is the mall a positive NPV project?

THERE ISN'T ENOUGH INFORMATION!

Must include all consequences of taking a decision

If you build the mall, then you cannot use the land for anything else.

Or sell it!

If the land can be sold for more than 5 million dollars, this is a negative NPV project.

The value of the land is what we call an "opportunity cost."

REFERENCE

Jonik. (2004). Playing acoustic guitar [Online image]. Retrieved August 31, 2015, from https://commons.wikimedia.org/wiki/File:Playing_acoustic_guitar.jpg

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

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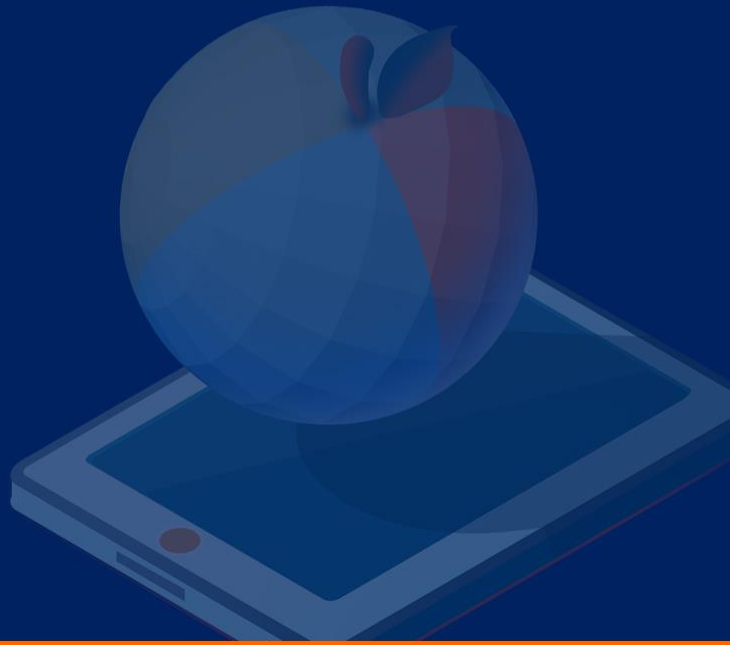
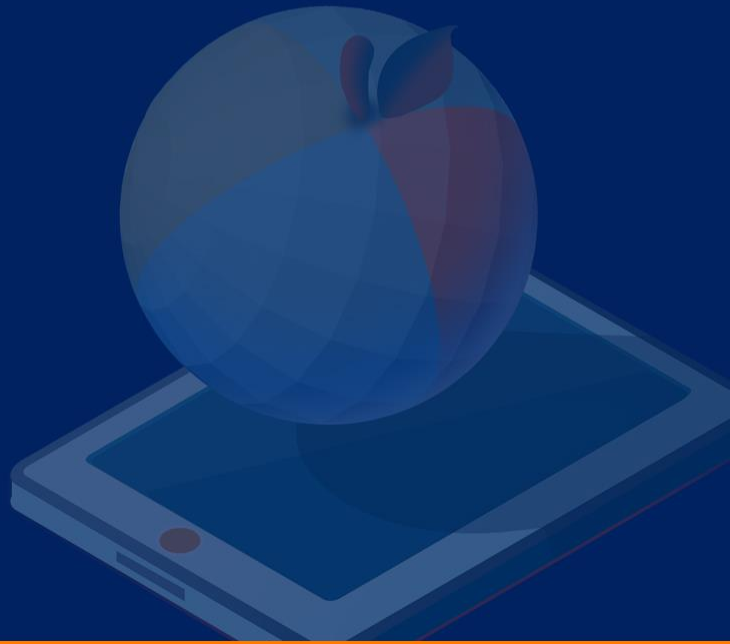


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-9

Real Options – Valuing R&D



REAL OPTIONS

Our NPV calculations assume that the decision is "all-or-nothing."

You either take the project or not. Also, once you take the project, you cannot cancel or modify it.

Investment projects come attached with "real options" to cancel or modify them, and they can create future opportunities (e.g., R&D).

INVESTING IN R&D (RESEARCH AND DEVELOPMENT) (1 OF 2)

The very purpose of R&D is to create an option to invest in the future.

(U.S. Food and Drug Administration, 2013)

INVESTING IN R&D (RESEARCH AND DEVELOPMENT) (2 OF 2)

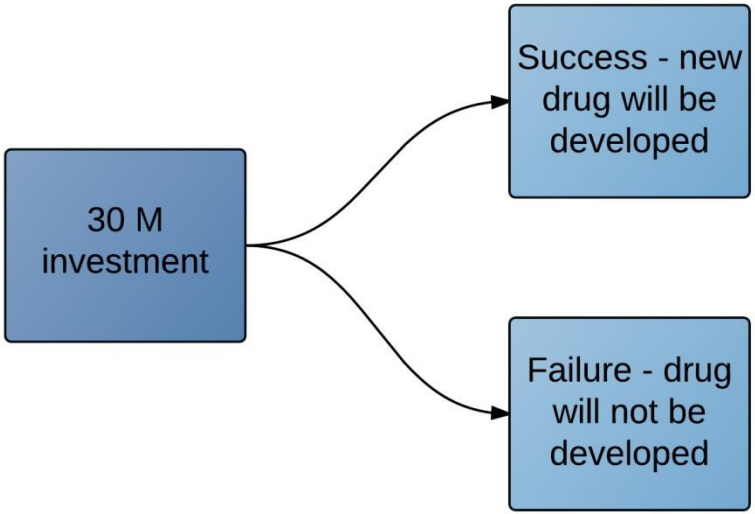
Example: a drug company must decide whether to invest 30M dollars in R&D for a new diabetes drug.

How do we compute the NPV of this R&D investment?

INVESTING IN R&D – DECISION TREES

R&D will not necessarily generate a useful drug.

Estimate the probability that the R&D will generate a useful new drug, and build a decision tree.



ESTIMATING PROBABILITIES

How can the drug company estimate the probability that the R&D is successful?

Obviously hard, especially for very novel projects

Use experience with other R&D or educated guesswork!

SOME DATA ON DRUG R&D

Four phases to prove safety and efficacy of a new drug

Phase 1: Test 20-100 healthy volunteers. 70% go to Phase 2

Phase 2: More volunteers, geographical expansion. 33% make it to Phase 3

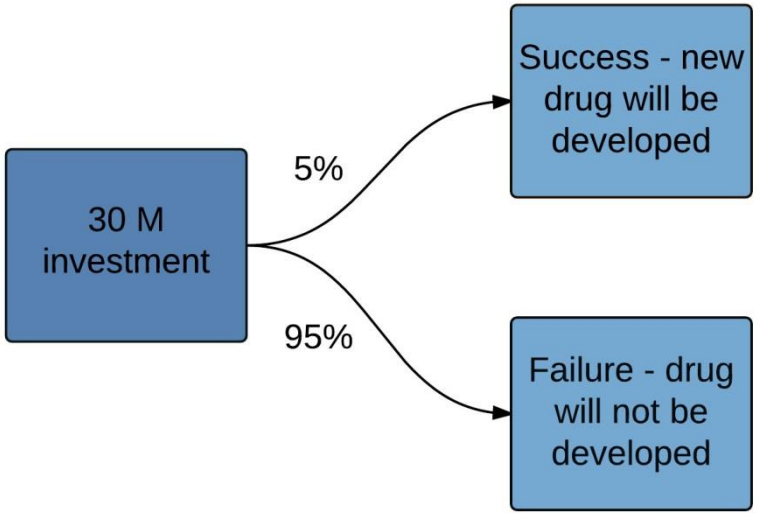
Phase 3: Number of years, thousands of patients, global

Phase 4: FDA approval

ESTIMATING PROBABILITIES

So, the probability of success will be very low for any individual drug.

Say it is 5%.



ESTIMATING FUTURE INVESTMENTS

Then, the drug company must estimate how much additional investment the new drug will require if the R&D is successful.

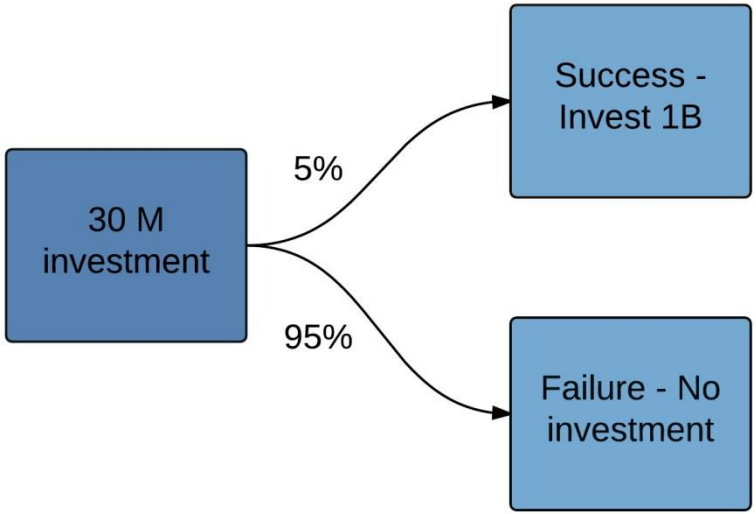
Some data (source: Wall Street Journal CFO journal, interview with Parexel International's CFO (02/21/14))

Each phase requires an increasing investment.

Phase 3 and 4 can each cost 500 million dollars for a single drug.

ESTIMATING CASH FLOWS

Say the required investment is $1B.



We must still estimate the profits that the drug will generate in case it is successful.

ESTIMATING CASH FLOWS

The FDA will grant a patent for a certain number of years (say 10 years). After that, competitors may copy the drug.

Suppose the drug generates $200 million a year for 10 years, and then cash flows will drop to $20 million in perpetuity (forever).

Suppose the discount rate is 6%.

What is the present value of these cash flows?

PRACTICE MAKES PERFECT

Yes, one more present value example!

PRESENT VALUE OF DRUG CASH FLOWS

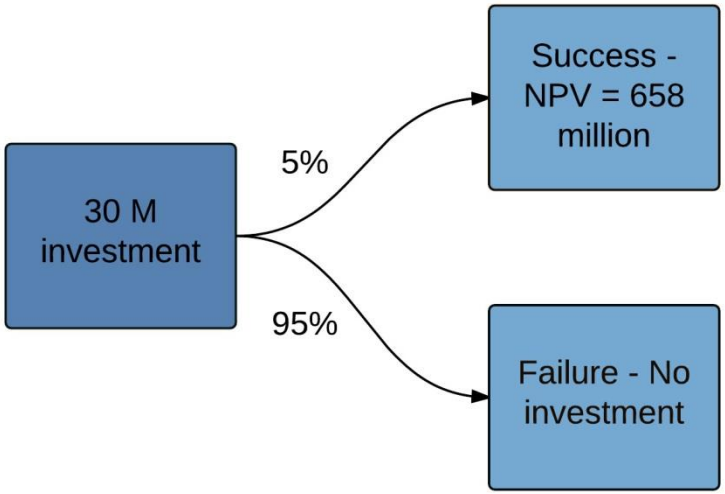
Investment	PV of cash flows	Cash flows												
		1	2	3	4	5	6	7	8	9	10	11	12	
-1000	1,658	200	200	200	200	200	200	200	200	200	200	20	20	…
0	0													

PV = 200/(1+6%) + 200/(1+6%)^2 + …. + 200/ (1+6%)^10 + (20/6%) / (1+6%)^10 = 1,658

So if the R&D proves to be successful, the drug will produce an NPV of 658 million dollars.

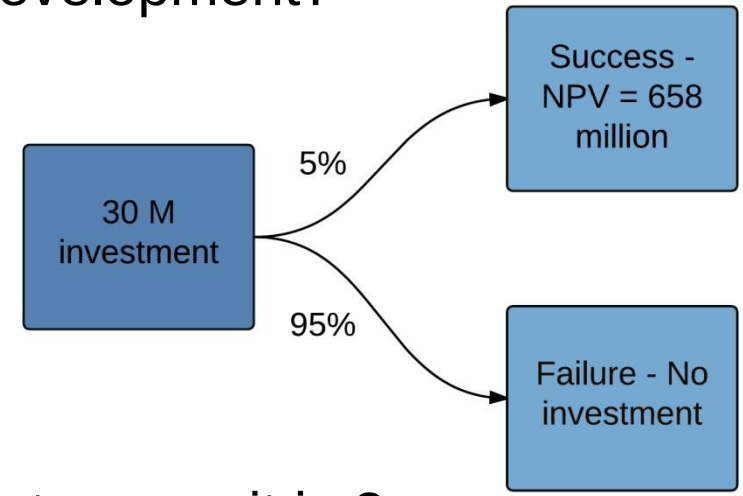
VALUING THE R&D INVESTMENT (1 OF 4)

We have almost all the numbers for our R&D valuation.



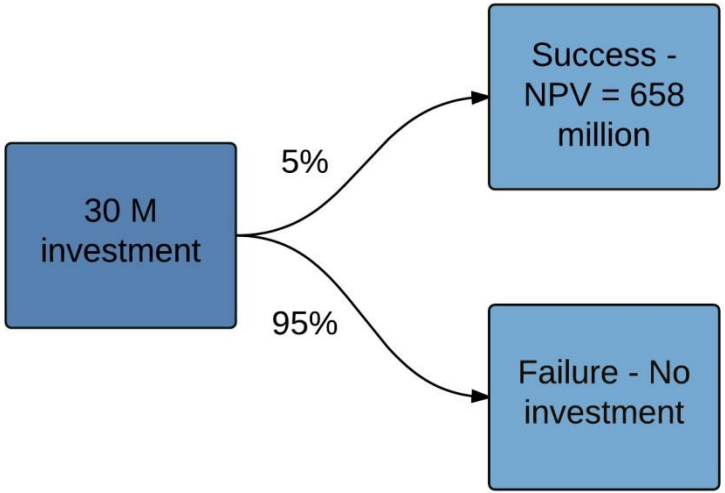
VALUING THE R&D INVESTMENT (2 OF 4)

How many years between the initial R&D investment and the drug development?



Let us say it is 3 years.

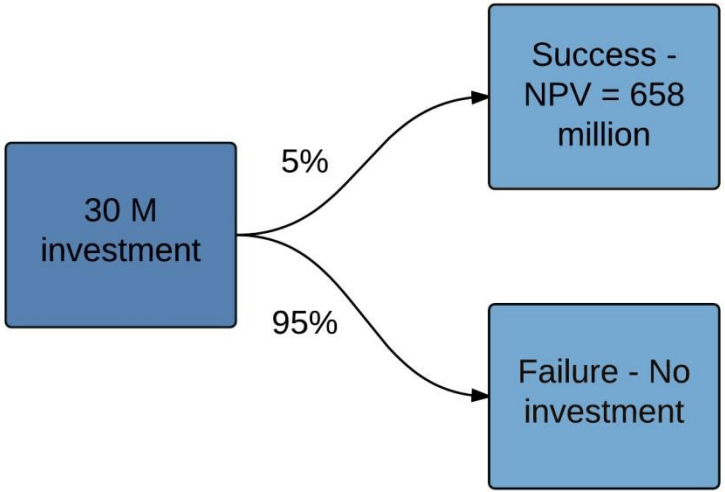
VALUING THE R&D INVESTMENT (3 OF 4)



The NPV of the R&D is

(Maxwell, 2007)

VALUING THE R&D INVESTMENT (4 OF 4)



The NPV of the R&D is

- 30 + 5%* 658 / (1 + 6%)^3 = -2.37 M

R&D – DISCUSSION

Despite the large potential benefit (NPV of 658 million), the drug should not be developed.

The risk of failure is too high, and it takes a long time to generate profits.

The company may consider lowering the cost of research or try to get results sooner!

REFERENCE

U.S. Food and Drug Administration. (2013). *"Miracle Cure!" Health Fraud Scams* [Online image]. Retrieved August 3, 2015, from https://www.flickr.com/photos/fdaphotos/8528312890/

Jonik. (2004). Playing acoustic guitar [Online image]. Retrieved August 31, 2015, from https://commons.wikimedia.org/wiki/File:Playing_acoustic_guitar.jpg

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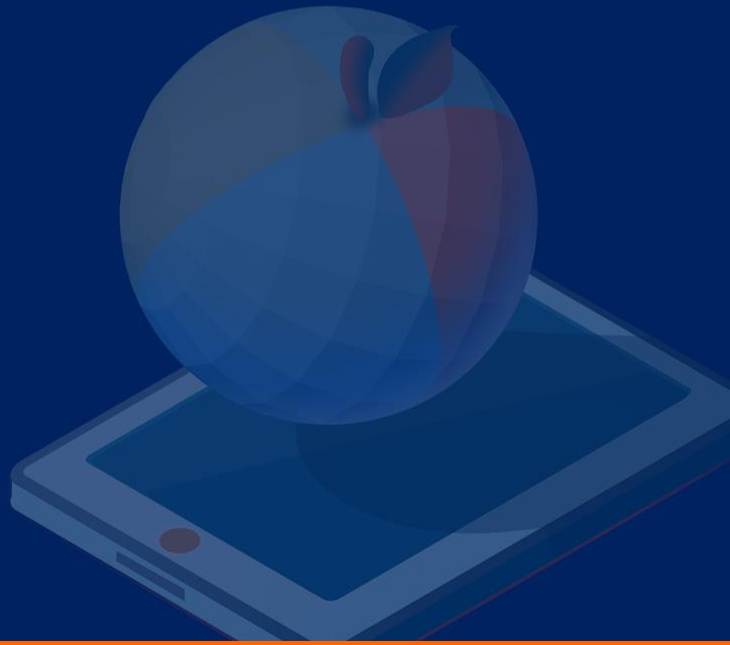
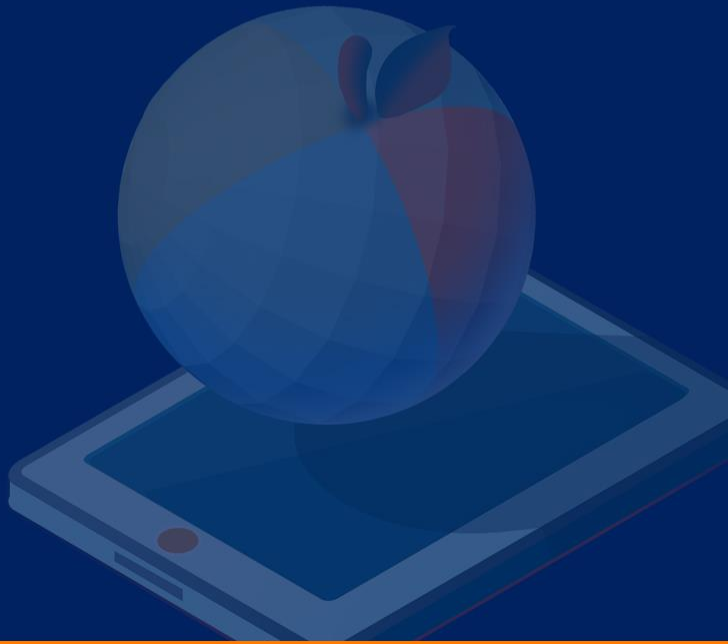


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-10

The Option to Wait – Gold Mine Example



THE OPTION TO WAIT

Companies may have the option to wait for more information before committing cash to a project.

We will illustrate this option with an example of a gold mine.

(Dace,n.d.)

THE GOLD MINE EXAMPLE (1 OF 2)

You own the rights to operate a gold mine in Siberia for three years, starting today.

- It costs $70,000 to open the mine.
- If you open the mine, you can extract 1000 ounces of gold a year for each of the next three years.
- Once the mine is open, it cannot be closed until the end of the three years (irreversibility).
- The current gold price is equal to $500 an ounce.
- Each year the price is equally likely to rise or fall by $50 from its level at the start of the year.

THE GOLD MINE EXAMPLE (2 OF 2)

The extraction cost is $460 an ounce. There are no fixed costs.

The discount rate is 5% and taxes are zero.

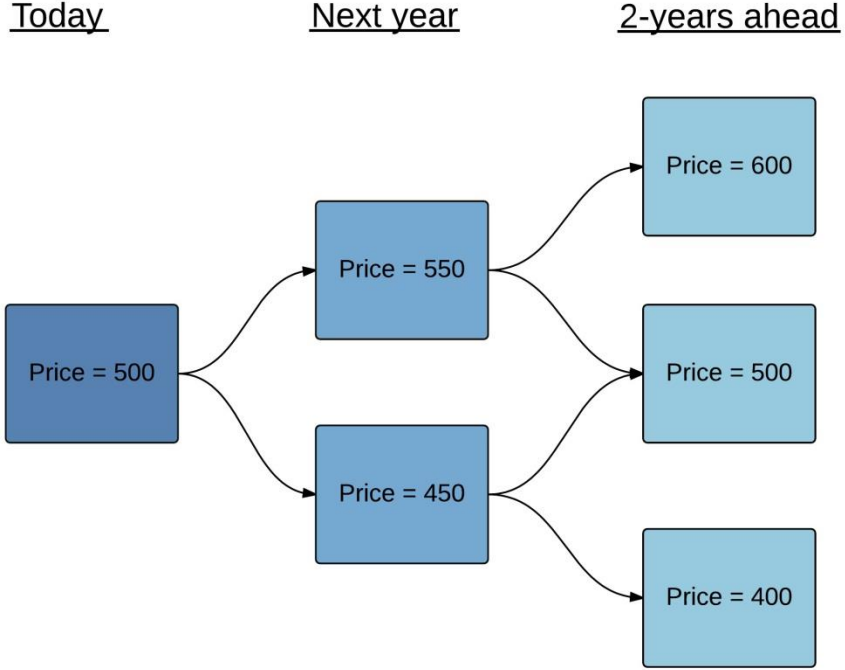
Cash flows happen at the beginning of the year.

So for example, if you open the mine you make 1,000*($500 - $460) immediately by selling the gold.

Should you open the mine now, or should you wait one year to see what happens to gold prices?

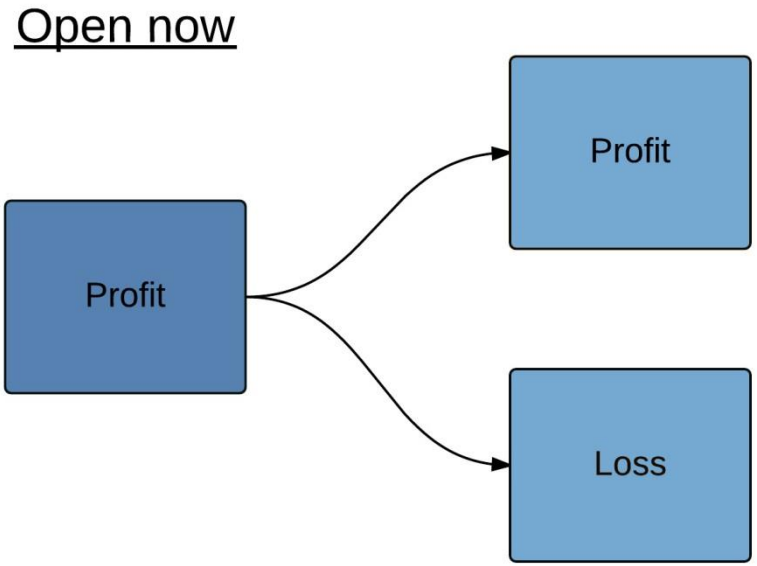
REPRESENTING UNCERTAINTY

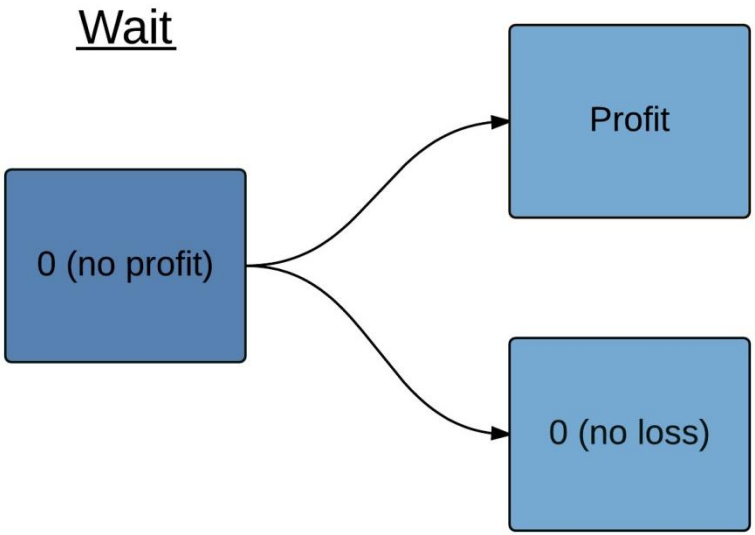
It will be useful to build a tree to visualize the possible changes.



WHAT IS THE TRADE-OFF THAT YOU FACE?

Before we do calculations, it is important to make sure we understand the problem.



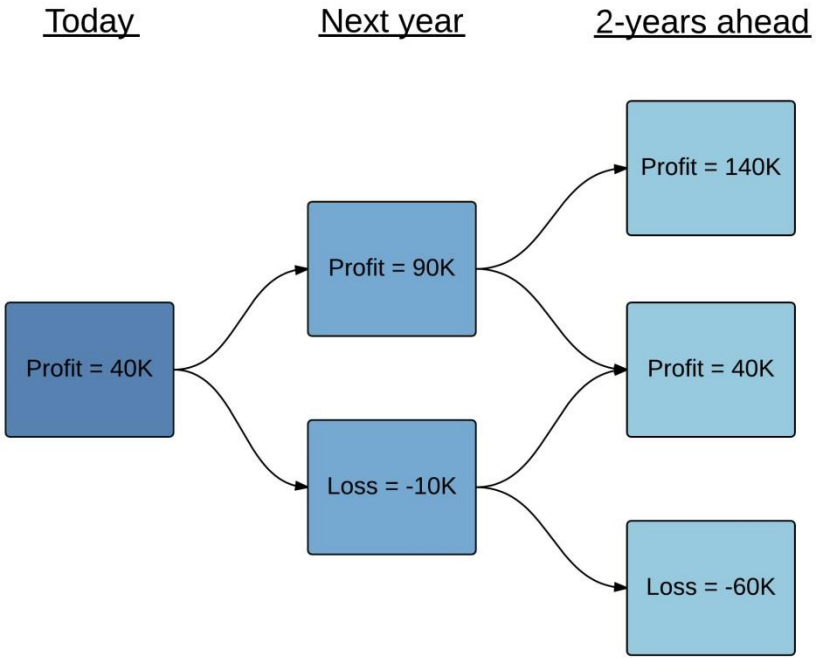


What is the main benefit of waiting?

What is the trade-off?

CALCULATIONS

Compute the profit or loss you will make in each state of the world if the mine is open.



CALCULATION – EXAMPLE

For example, the profit that you make today is

40,000 = 1,000 * (500 – 460)

If the gold price goes to 450:

-10,000 = 1,000 *(450 – 460)

NPV OF OPENING TODAY

In this case, you will realize all profits and losses above

NPV = -70 + 40 +

+ (50%*90 – 50%*10)/ (1+ 5%) +

+ (25%* 140 + 50%*40 – 25%*60)/ (1+5%)^2

NPV = 44,367

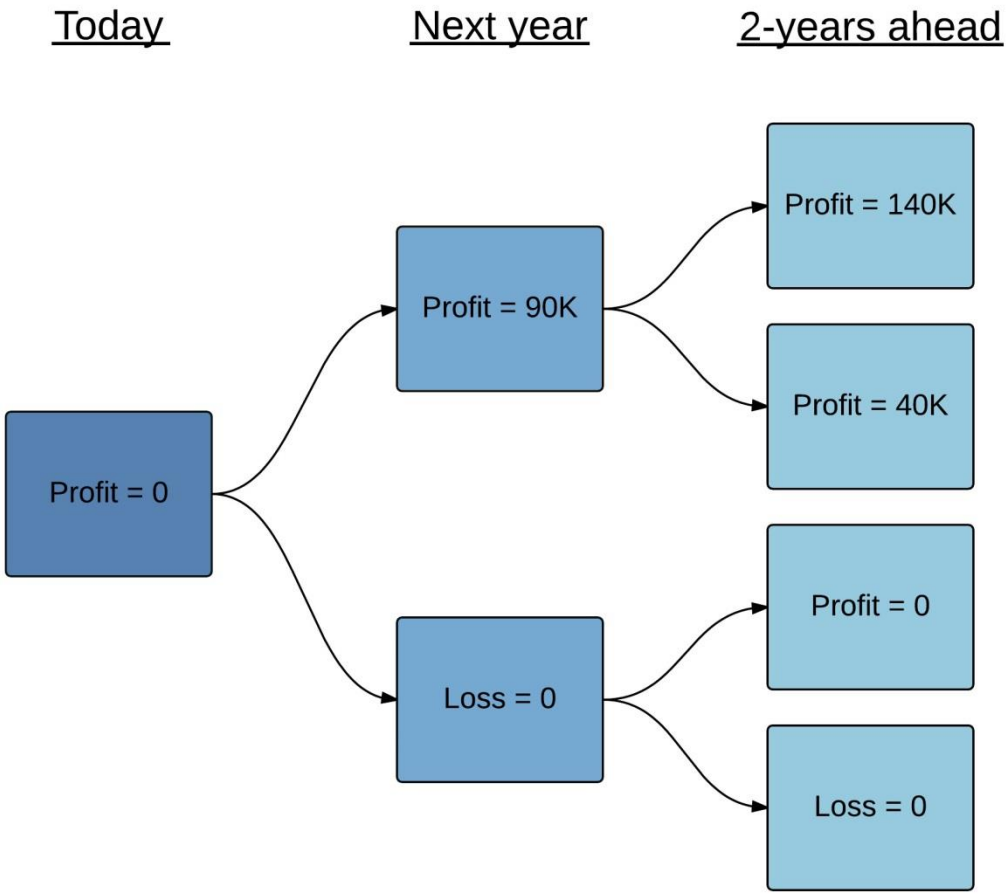
Why is the probability of the 140K profit equal to 25%?

THE NPV OF WAITING

What does the profit tree look like if you wait to open until tomorrow?

(Maxwell, 2007)

THE NPV OF WAITING



THE NPV OF WAITING

Given this tree, we can compute the NPV of waiting.

NPV of waiting =

50%*(-70 + 90)/ (1+ 5%) +

+ (25%* 140 + 25%*40)/ (1+5%)^2

NPV = 50,340

MAKING A DECISION

The NPV of opening now is 44,367.

The NPV of waiting is 50,340.

What should you do?

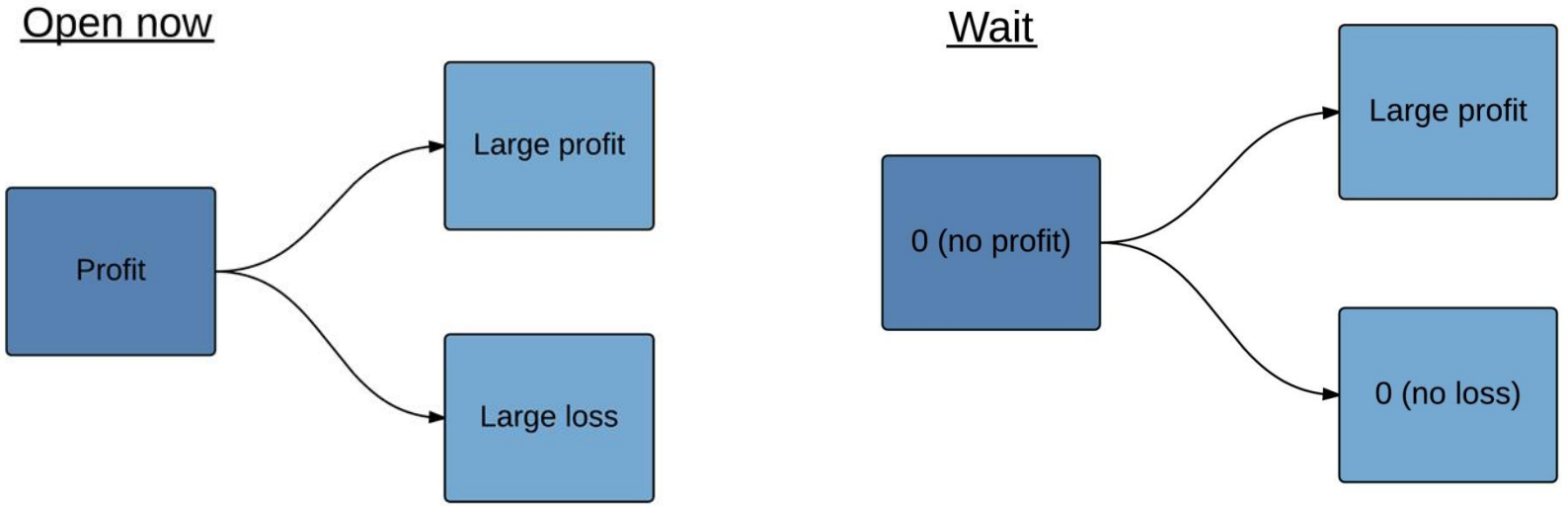
MAKING A DECISION

Wait! Opening the mine is a good decision, but waiting is even better!

(Unknown, 1988)

UNCERTAINTY AND THE OPTION TO WAIT

The value of the option to wait increases with the volatility in the price of gold. Why? When volatility is high…



Waiting can eliminate a larger loss. Zero looks better!

COMPETITION AND THE OPTION TO WAIT

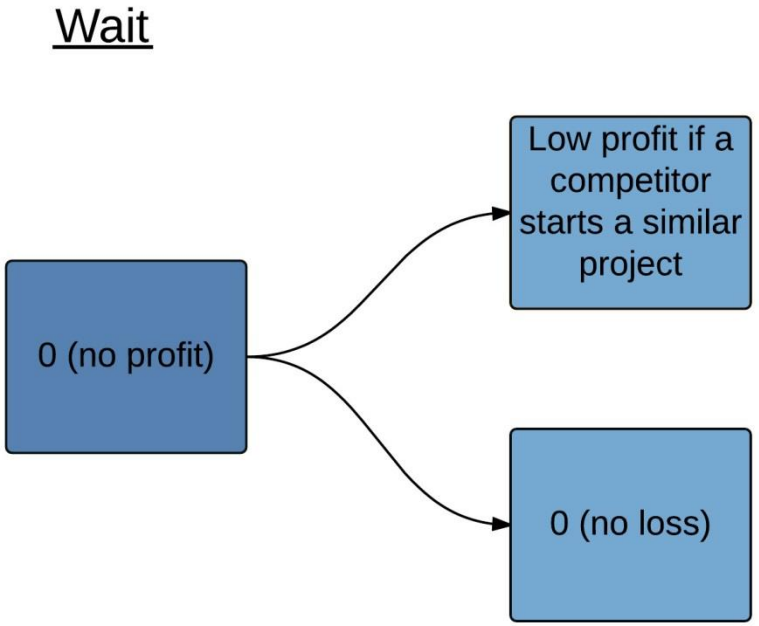
We assumed you had an exclusive right to open the mine.

A monopoly!

In most cases, companies will not have the ability to wait because competitors may decide to start similar projects.

COMPETITION AND THE OPTION TO WAIT

Decision tree with competition



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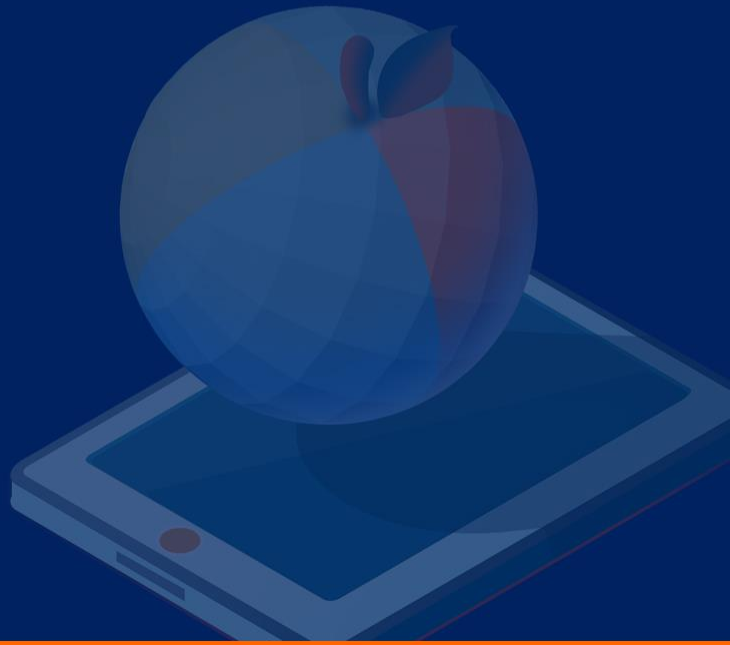
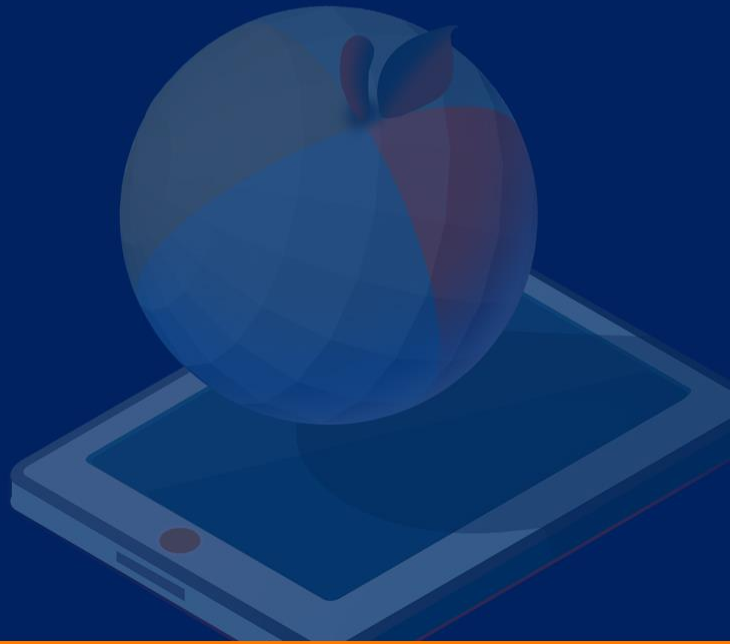


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-11

The Option to Abandon



OPTIONS TO ABANDON UNPROFITABLE PROJECTS

(1 OF 2)

(commons.wikimedia.org/flamenc, 2013)

OPTIONS TO ABANDON UNPROFITABLE PROJECTS

(2 OF 2)

This is a very important option.

All projects should be constantly reevaluated once new information comes in.

Option to abandon can be exercised by shutting down projects and divisions or by selling projects to other companies (M&A)

EXAMPLE: GOLD MINE PROBLEM

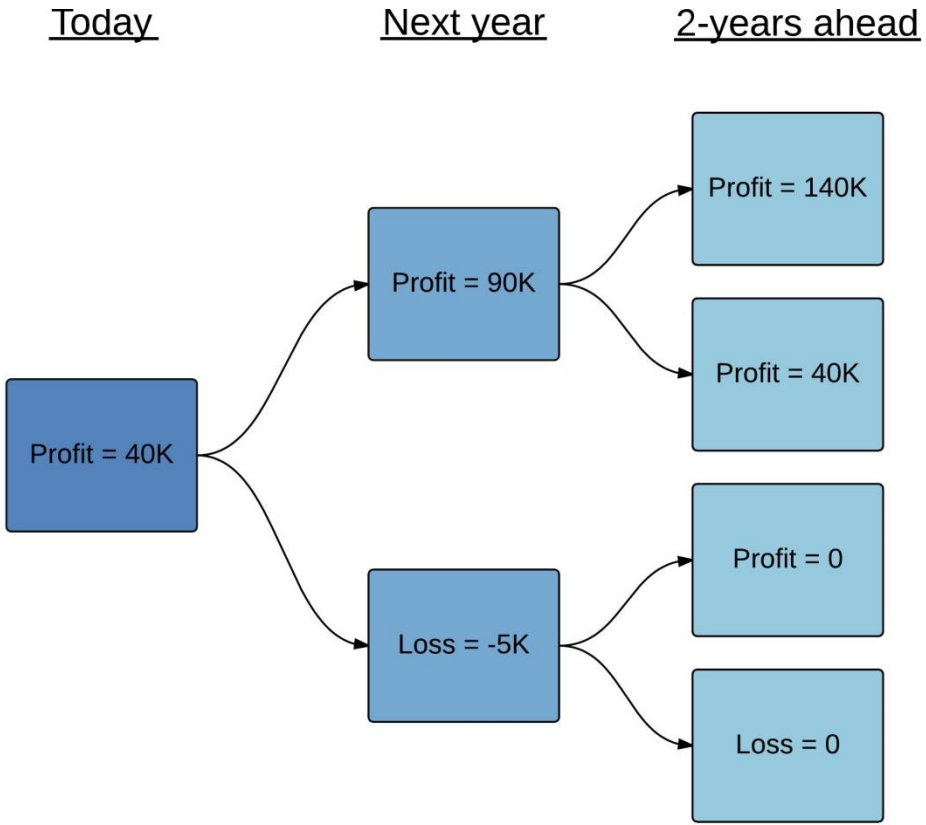
Suppose you can now close the mine next year by paying a decommissioning cost of $5,000.

How does that change your analysis?

We can now consider the option of opening today but closing tomorrow if the gold price goes down.

CLOSING THE GOLD MINE

(1 OF 3)



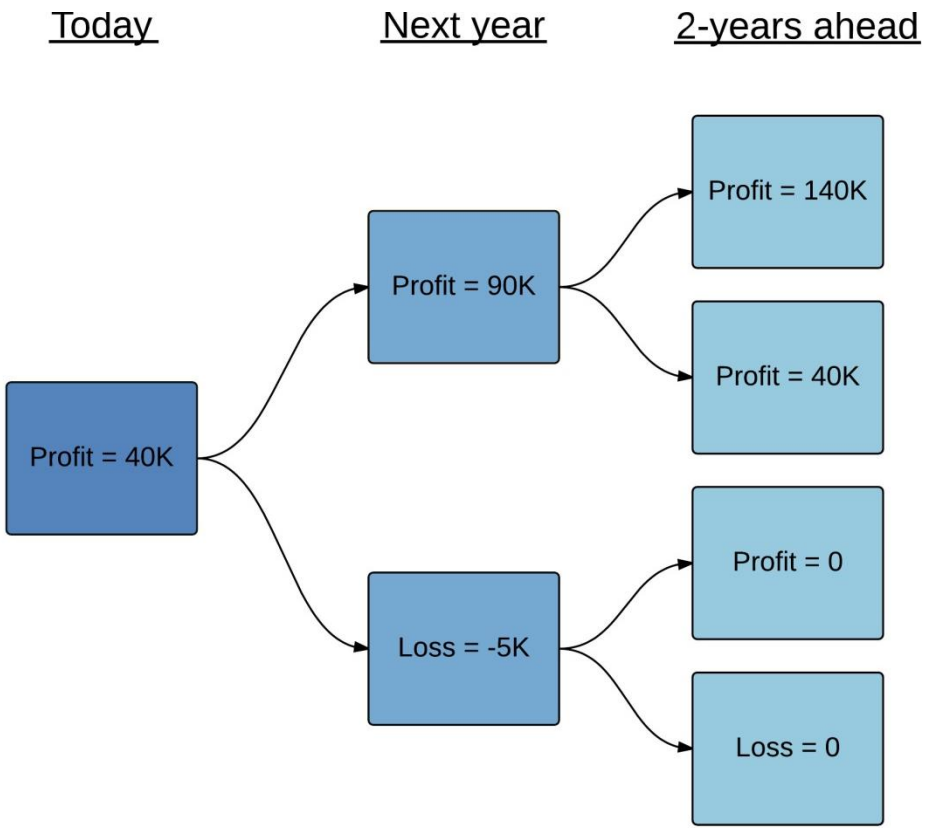
CLOSING THE GOLD MINE

(2 OF 3)

What is the NPV of opening today and closing tomorrow if the mine becomes unprofitable?

(Maxwell, 2007)

CLOSING THE GOLD MINE (3 OF 3)



OPTION TO ABANDON – ANALYSIS

The NPV of opening now and not closing until the end is 44,367.

The NPV of waiting is 50,340.

The NPV of opening now and closing tomorrow if the gold price goes down is 51,292.

The optimal decision is now to open today and close tomorrow if the price goes down.

IRREVERSIBILITY AND THE OPTION TO WAIT

If the decommissioning cost (the cost of closing the mine early) were higher, then the option to wait would again give the highest NPV.

Investments that have high shut down costs are called “irreversible investments.”

EXAMPLES OF IRREVERSIBLE INVESTMENTS

Building a factory

Testing a drug on thousands of patients in many different countries

These are the investments for which the option to wait is most valuable.

REFERENCE

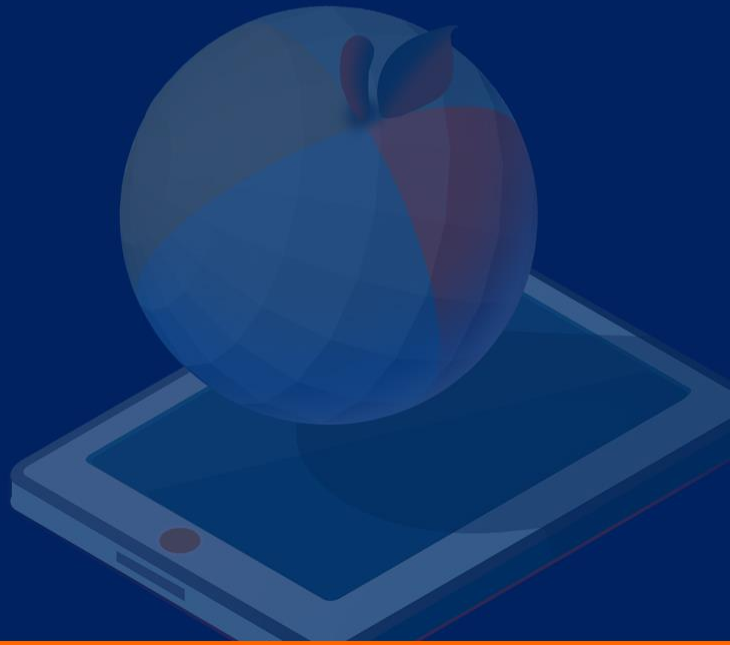
flamenc. (2013). *Point Reyes 2013 shutdown* [Online image]. Retrieved August 3, 2015, from https://commons.wikimedia.org/wiki/File:Point_Reyes_2013_shutdown.jpg

Maxwell, S. (2007). *LuMaxArt FS Collection Orange0059* [Online image]. Retrieved July 16, 2015, from https://www.flickr.com/photos/lumaxart/2364667079

FINANCIAL EVALUATION AND STRATEGY:

CORPORATE FINANCE

with Heitor Almeida

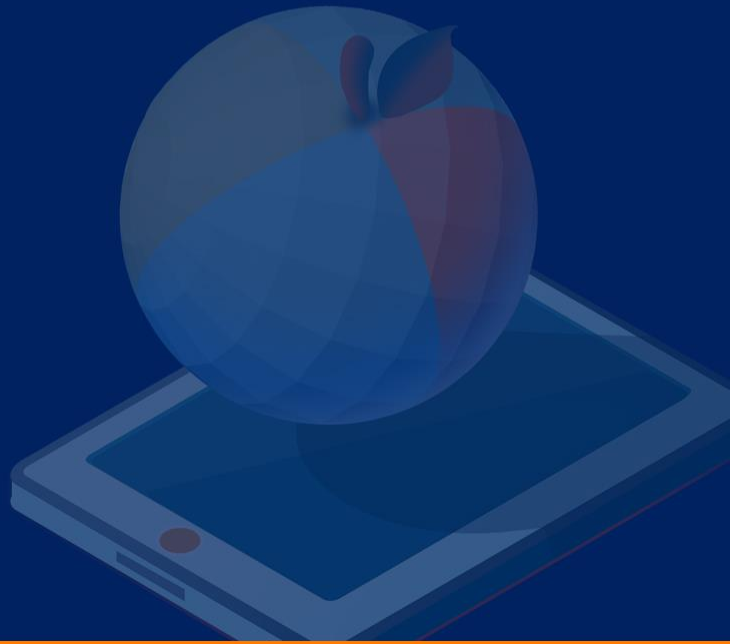


MODULE 3

Making Investment Decisions

VIDEO LESSON 3-12

Module 3 Review



WHAT WE'VE LEARNED IN MODULE 3 (1 OF 3)

Why using net present value (NPV) is equivalent to maximizing shareholder value

To build cash flows for NPV calculations

How to compute NPV and how to use NPV to make decisions about projects

The concept of internal rate of return (IRR) on a project

WHAT WE'VE LEARNED IN MODULE 3 (2 OF 3)

The relationship between NPV and the IRR

How to compute IRR and how to use IRR to make decisions about projects

Situations in which you should not use IRR to make investment decisions

To incorporate real options into investment decisions using decision trees

WHAT WE'VE LEARNED IN MODULE 3 (3 OF 3)

How to make decisions about research and development (R&D) investments

To value the option to wait and to incorporate it into investment decisions

How to incorporate an option to abandon into investment decisions