# BLOC-516: Principles of Money, Banking, and Finance

## Time Value of Money


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# Learning Outcomes

After this section you will be able to:

- Explain what we mean with the concept of the Time Value of Money and why it is important.
- Where does the Time Value of Money come from.
- Apply the Time Value of Money Equation (for example for discounting amounts).

Note:

It is possible that you are already familiar with this topic; if this is the case just go through the slides to make sure the Learning Outcomes above are indeed achieved.

# Time Value of Money

The most fundamental principle of Finance

# Time Value of Money

- Money today at hand > Money tomorrow
- "A dollar today is worth more than a dollar tomorrow"
- (The first basic principle of Finance!)
- Better sooner than later (time preference)

# Why better sooner than later?

- **Opportunity Cost**
  - Save (interest)
  - Invest (return)
  - Pay off debt
  - Spend now (instant gratification)

- **Risk**
  - Just a promise!

- **Inflation**
- **Liquidity**

# Value perception

**€100m at hand now > The promise of €100m in the future**

# Value perception and r

- If I choose to **accept the promise**, I inevitably **sacrifice** having the **money at hand today**.

- Therefore, I can **demand a positive return**, **r** (**i.e. more money!**) as a **compensation** for the Opportunities lost, for the Risk, and for the Inflation!

So, if I invest an amount P now, in the future, I expect to get:

**P + something extra**

You have to promise me that extra.

## Value perception and r

So, let **F** be the future amount of money that I require to be promised to me in order to accept to invest **P** today.

For one year, F is:

F = P + something extra

F= P + P*r

**F =P(1+r)**

To generalize for more than one year (or time periods, t), this becomes:

**F =P(1+r)(1+r)(1+r) (1+r)….(1+r)** [i.e. we have t parentheses]

## The Equation

What should be the "Promised Future Amount" F in t years in order for me to be willing to invest the amount P now, given r?

$$F = P(1+r)^t \tag{Eq. 1}$$

**F** = Promised Future Amount (or simply "Future Value")

**P** = Price of the Promise (or "Present Value"), how much you invest now

**t** = How much time you have to wait to get F (in time periods, e.g. years), "time to maturity"

**r** = Rate of Return

What should be the "Promised Future Amount" F to receive in t= 2 years in order for me to be willing to invest the amount P = €100 now, given r is 10% = 0.10?

$$\boxed{F = P(1+r)^t}$$

F=?
P=€100
t=2 years
r=0.10

$$F = €100(1+0.10)^2$$

$$F = €100(1.10)^2$$

$$F = €100(1.21)$$

$$\boxed{F = €121}$$

I should be happy if the "Promised Future Amount" F is at least €121.

# The (Present Value) Equation

**How much should I be willing to invest (P) now if the "Promised Future Amount" is F in t years, given r?**

$$P = \frac{F}{(1+r)^t} \qquad \text{Eq. 2}$$

**F** = Promised Future Amount (or simply "Future Value")

**P** = Price of the Promise (or "Present Value") , how much I invest

**t** = How much time you have to wait to get F (in time periods, e.g. years), "time to maturity"

**r** = Rate of Return

How much should I be willing to invest (P) now if the "Promised Future Amount" (F) is €121 to be paid in t=2 years, given r is 10%=0.10?

$$P = \frac{F}{(1+r)^t}$$

P=?
F=€121
t=2
r=0.10

$$P = \frac{€121}{(1+0.10)^2}$$

$$\boxed{P = €100}$$

I would be willing to invest a maximum of €100.

# The Present Value Equation

**r** = risk-free rate + risk premiums

$$P = \frac{F}{(1+r)^t}$$

The greater the perceived risk, the higher the required risk premium, thus
the higher the required return (**r**) one demands, and the lower the price (**P**)one is willing to pay for some expected future benefit (**F**).

$$\downarrow P = \frac{F}{(1 + \uparrow r)^t}$$

- **What is the P (or what the Price should be) of an asset that promises to pay F= €1100 in t = 5 years assuming (a) r = 5%? and (b) assuming r = 10%?**

P = ? t=0________________________________________t=5 F = €1100

**(a) Plugging in the values (r=5%):**

**P** = €1100/(1+0.05)^5
= €1100/(1.05)^5
= €1100/1.2762815625
=**€861.88** (rounded)

$>$

**(b) Plugging in the values (r=10%):**

**P** = €1100/(1+0.10)^5
= €1100/(1.10)^5
= €1100/1.61051
=**€683.02** (rounded)

When r = 5%, I am willing to pay maximum €861.88 for the promise to receive €1100 in 5 years, while when r = 10%, I am willing to pay only a maximum of €683.02.

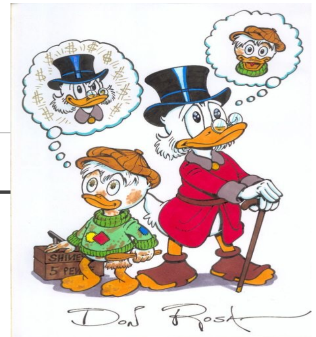
# The Present Value Equation

**t** : time to maturity/expiration, i.e. how many time periods one has to wait to get F after investing P.

$$P = \frac{F}{(1+r)^{t}}$$

The longer one expects to wait (**t**) for some future benefit (**F**), the less one is willing to pay (**P**) for it.

$$P = \frac{F}{(1+r)^t}$$



**What is the P (or what the Price should be) of an asset that pays F= €1100 in (a) t = 5 years assuming r = 5%? And (b) t = 7 years, assuming same r?**

P = ?

t=0________________________________________t=5

t=0____________________________________________________t=7

F = €1100

**(a) Plugging in the values (t=5):**

**P** = €1100/(1+0.05)^5
= €1100/(1.05)^5
= €1100/1.2762815625
=**€861.88** (rounded)

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**(b) Plugging in the values (t=7):**

**P** = €1100/(1+0.10)^7
= €1100/(1.05)^7
= €1100/1.407100422656
=**€781.75** (rounded)

When r = 5%, I am willing to pay maximum €861.88 for the promise to receive €1100 in 5 years, while, I am willing to pay only a maximum of €781.75 to receive it in 7 years.

## Risk and Reward

**r** = Rate of Return= Risk-free rate + Risk Premiums

$$P = \frac{F}{(1+r)^t}$$

If one perceives higher risk (r) they demand a higher reward, i.e. to be promised a higher future amount (F).

## Notation Note

- r is denoted also as i
- Also, P as PV
- and F as FV
- Even t is sometimes denoted as n (number of time periods)

$$\text{Let } i = .10$$

$$\text{In one year } \$100 \text{ X } (1+0.10) = \$110$$

$$\text{In two years } \$110 \text{ X } (1+0.10) = \$121$$

$$\text{or } 100 \text{ X } (1+0.10)^2$$

$$\text{In three years } \$121 \text{ X } (1+0.10) = \$133$$

$$\text{or } 100 \text{ X } (1+0.10)^3$$

$$\text{In } n \text{ years}$$

$$\$100 \text{ X } (1+i)^n$$

# Also note:

The Time Value of Money Equation can be also solved for r and for t.

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