Δημοκρίτειο Πανεπιστήμιο Θράκης

Τμήμα Οικονομικών Επιστημών

Αριστεία. Επιστήμη. Καινοτομία.

Financial Assets

Time Value of Money

Annuities, Stocks, Bonds

Efficient Market Hypothesis

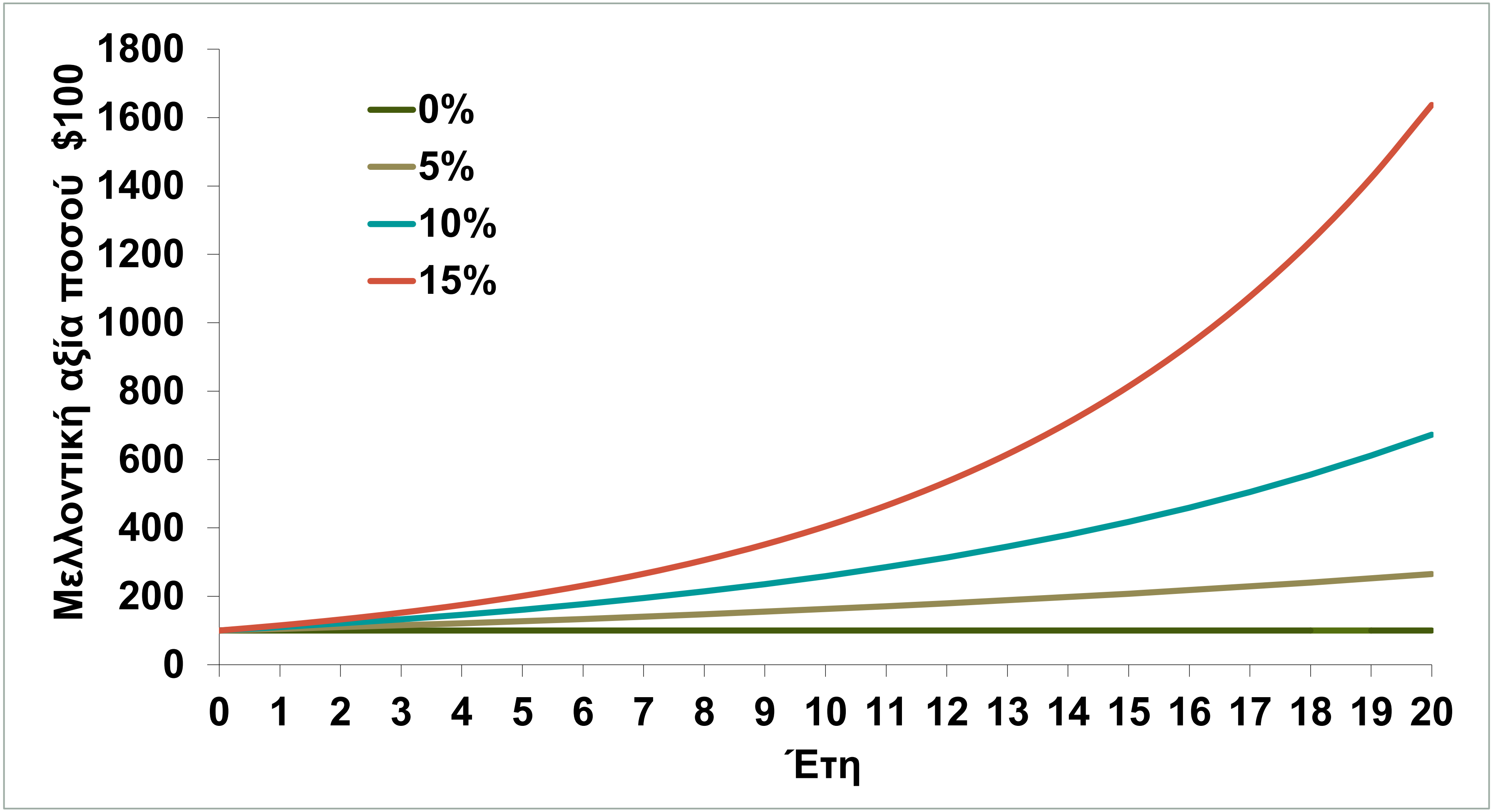
Periklis Gogas

Professor

Future Value

- The value of money is different over time
- Why?
- No compounding $$FV = PV(1 + rt)$$
- With compounding $$FV = PV(1 + i)^t$$

Ρόλος επιτοκίου - ανατοκισμός



Present Value

- Παρούσα αξία μελλοντικών πληρωμών

$$\text{Present Value} = \frac{\text{FV}}{(1+r)^n}$$

where:

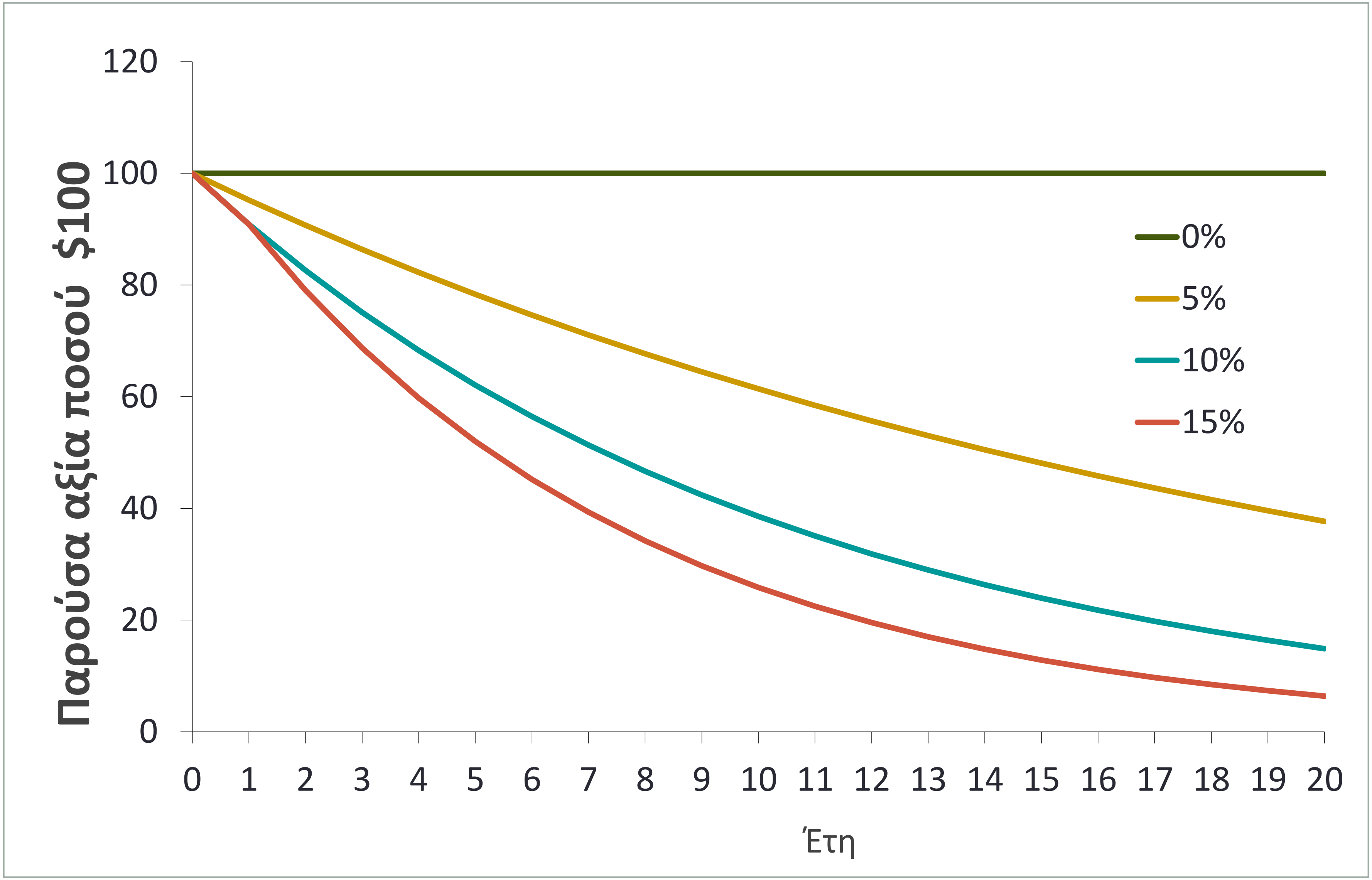
$$\text{FV} = \text{Future Value}$$

$$r = \text{Rate of return}$$

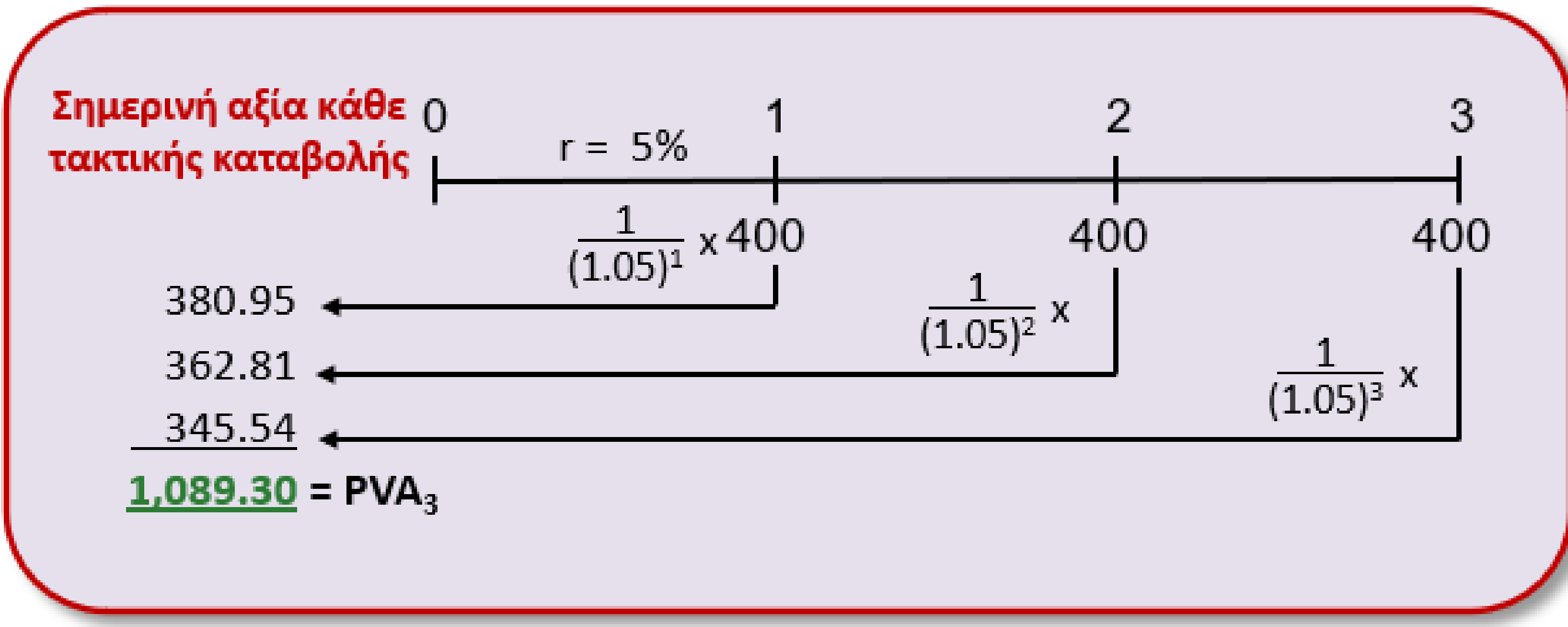
$$n = \text{Number of periods}$$

Ρόλος επιτοκίου – Παρούσα Αξία

DEPARTMENT OF ECONOMICS MBA



Ποια είναι η παρούσα αξία ενός 3ετούς προγράμματος σταθερών καταβολών $400 για r = 5%?



Annuities
Ράντες

Annuities

What is an Annuity?

- Fixed periodic payment
- For a given number of periods
- A given interest rate
- Compounded

What is the value of an annuity?

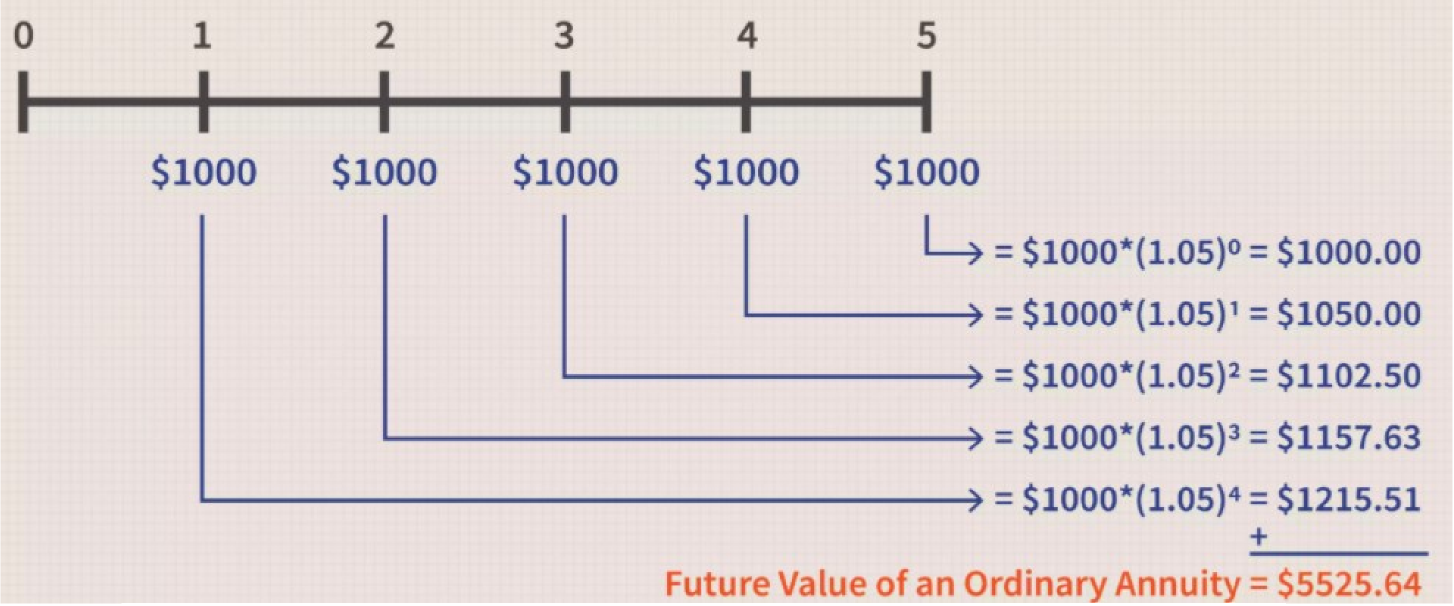
- Two relevant values:
  - At the start – Present Value
  - At the end – Future Value

Examples:

- Kid: $500, for 18 years, at 4%, compound – future value
- Lottery: $1.8 billion, 30 years, $60 million per year, 5% - present value

Ordinary Annuity – Future Value

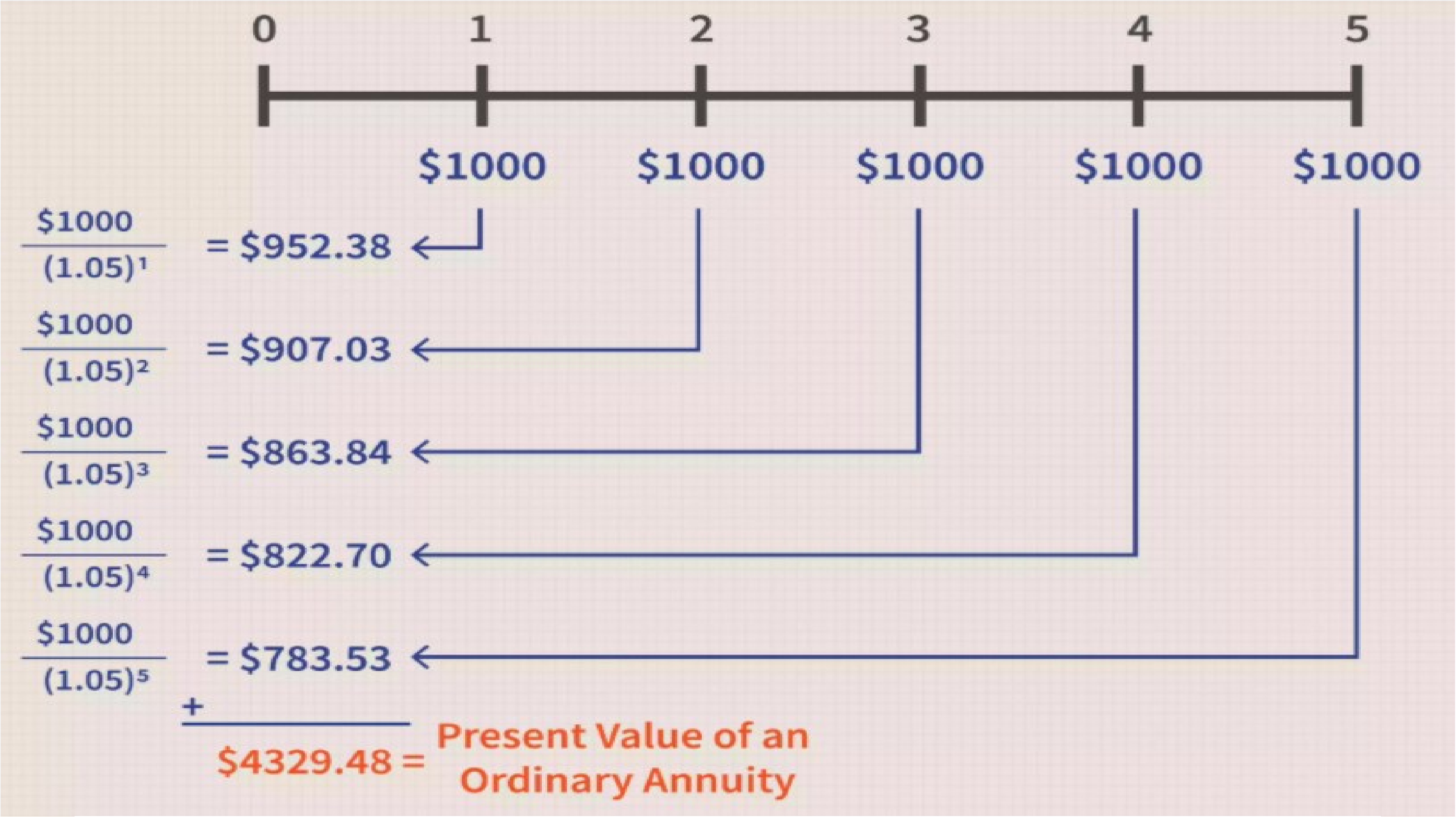
- Amount is deposited at the **end** of each period with i=5%
- In Excel =FV(rate, nper, pmt, [pv], [type]), type = 0 is for end of period and is the default value.



$$FV_{\text{Ordinary Annuity}} = C \times \left[\frac{(1+i)^n - 1}{i} \right]$$

Ordinary Annuity – Present Value

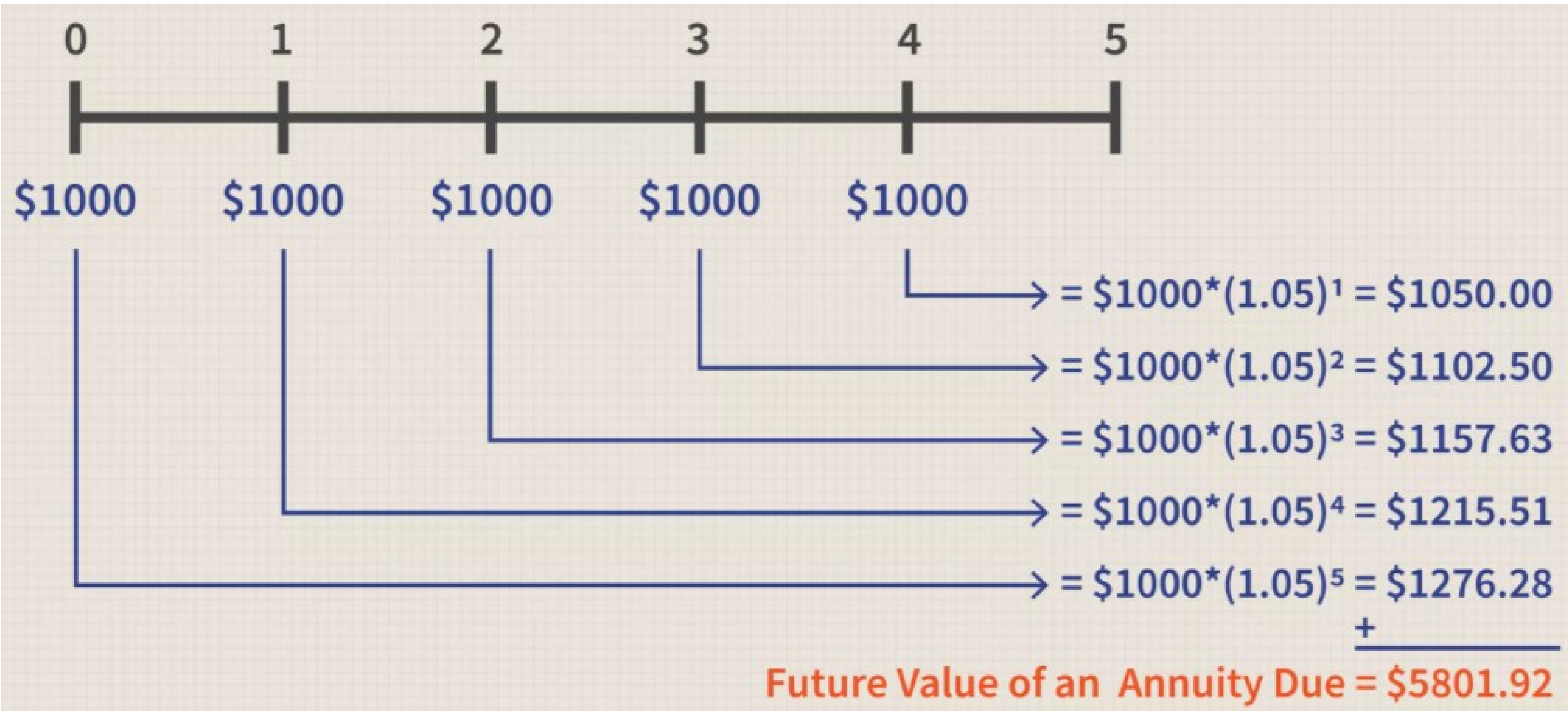
Excel: PV(rate, nper, pmt, [fv], [type]) – type = 0



$$PV_{\text{Ordinary Annuity}} = C \times \left[\frac{1-(1+i)^{-n}}{i}\right]$$

Annuity Due – Future Value

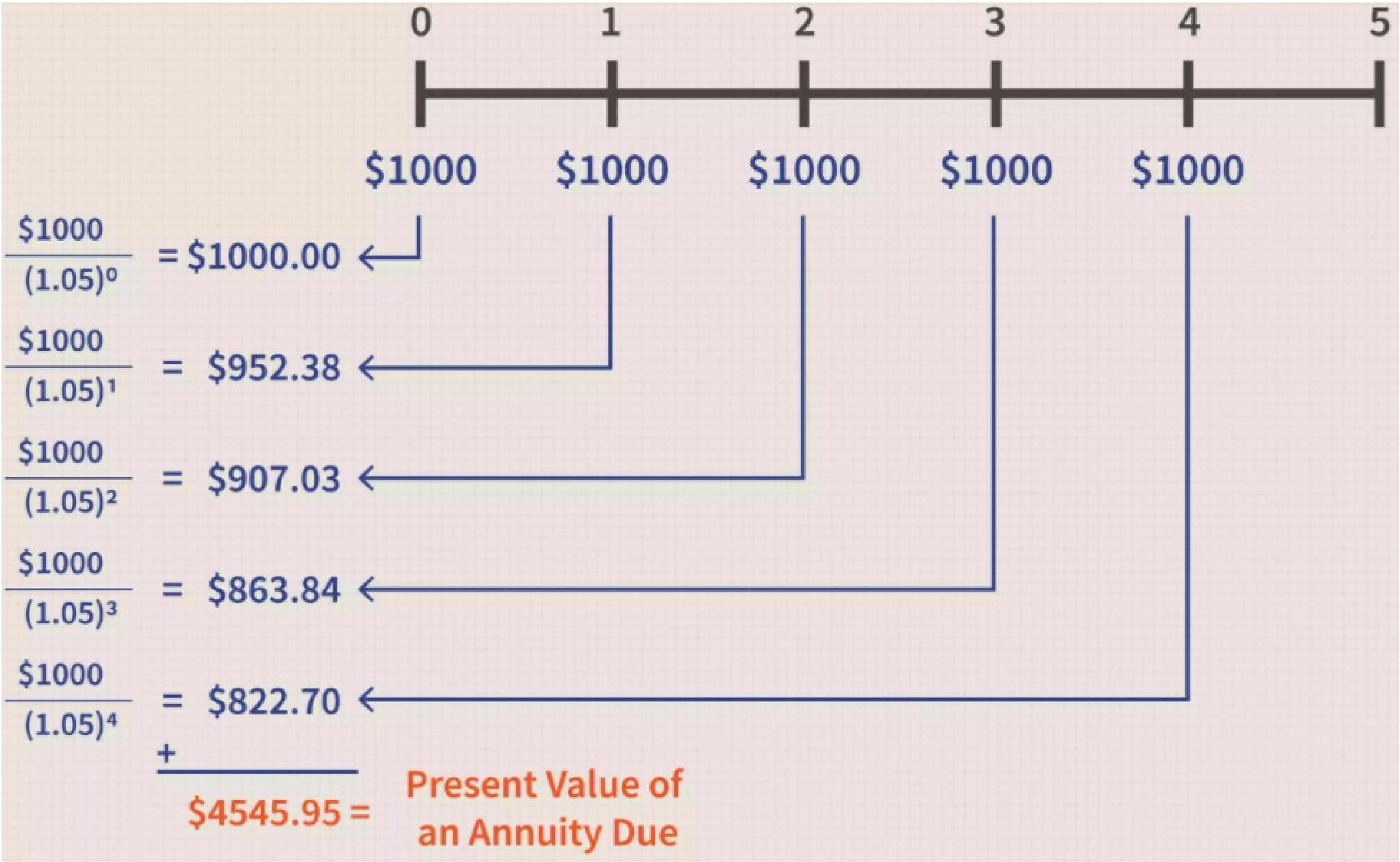
- Amount is deposited at the **start** of each period
- In Excel: FV(rate, nper, pmt, [pv], [type]), type=1 is for end of period and is the default value.



$$FV_{\text{Annuity Due}} = C \times \left[\frac{(1+i)^n - 1}{i} \right] \times (1+i)$$

Annuity Due – Present Value

Excel: PV(rate, nper, pmt, [fv], [type]) – type = 1



$$PV_{\text{Annuity Due}} = C \times \left[\frac{1-(1+i)^{-n}}{i}\right] \times (1+i)$$

Perpetual Annuity

$$\text{PV} = \frac{C}{(1+r)^1} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} \cdots = \frac{C}{r}$$

where:

PV = present value

C = cash flow

r = discount rate

- What is the Future Value?

Stock Valuation

Stock Valuation

- Variable dividend
  Current stock value is the present value of all future cash flows - dividends:

$$P_0 = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \ldots + \frac{D_\infty}{(1+r)^\infty}$$

- Constant dividend
  If $D_1 = D_2 = \ldots$, then

$$P_0 = D_1 \times \sum_{t=1}^{\infty} \frac{1}{(1+r)^t} = D_1 \times \frac{1}{r} = \frac{D_1}{r}$$

MBA

- If we have constant dividend growth *g:*

$$P_0 = \frac{D_0 \times (1+g)^1}{(1+r)^1} + \frac{D_0 \times (1+g)^2}{(1+r)^2} + \ldots + \frac{D_0 \times (1+g)^\infty}{(1+r)^\infty}$$

$$P_0 = D_0 \cdot \sum_{i=1}^{\infty} \left(\frac{1+g}{1+r} \right)^i = D_0 \cdot \frac{1+g}{r-g}$$

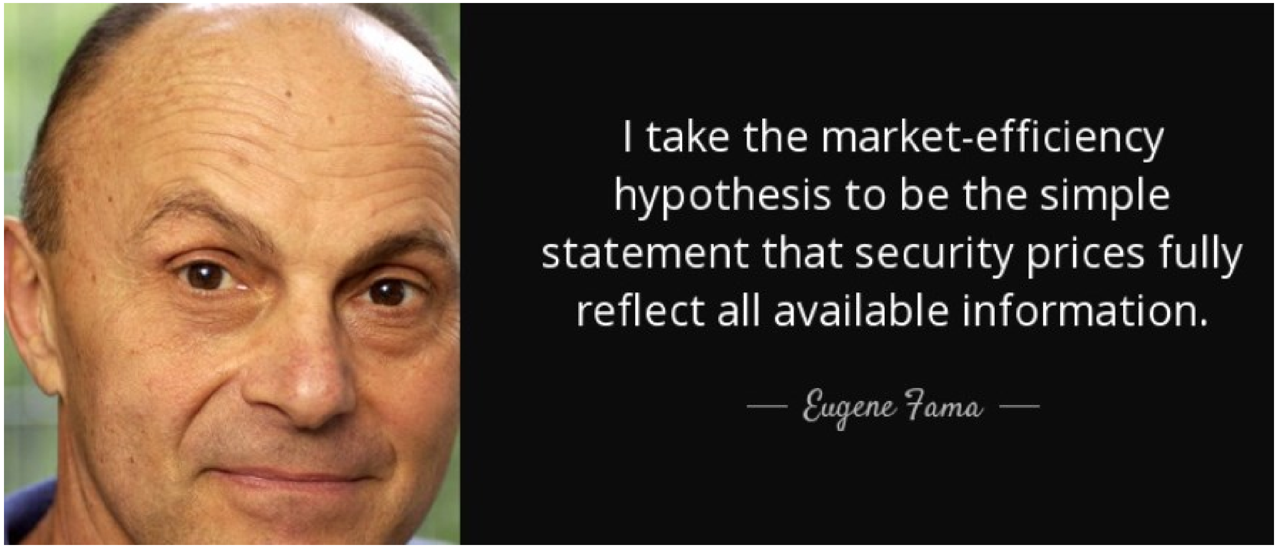
but $D_0\,(1+g) = D_1$

$$P_0 = \frac{D_1}{r-g}$$

0

Efficient Market Hypothesis

- Current stock price at t: $$P_0 = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \ldots + \frac{D_\infty}{(1+r)^\infty}$$
- We **estimated** D_i based on I_t .
- We used **all available information** at t.
- When will the price of the stock **change**?
- When we have changes in I_t = **new information**, **news** on the firm.
- News are **by definition random**.
- Thus, **stock price changes** are **random**.



Efficient Market Hypothesis

Types of Efficiency

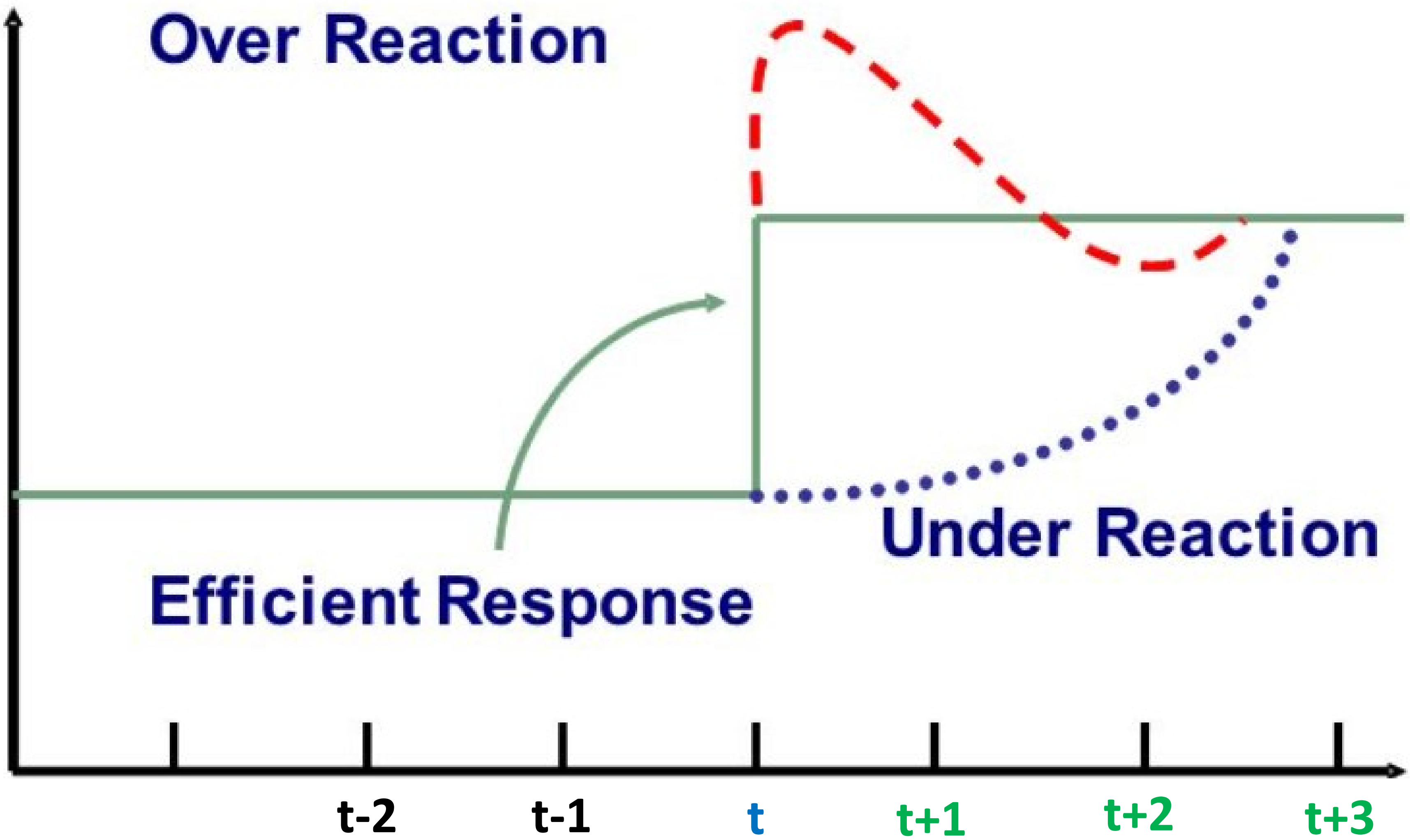
- **Weak form efficiency**
  This type of EMH claims that **all past prices of a stock** are reflected in today's stock price. Therefore, technical analysis cannot be used to predict and beat the market.
- **Semi-strong form efficiency**
  This form of EMH implies **all public information** is calculated into a stock's current share price. Neither fundamental nor technical analysis can be used to achieve superior gains.
- **Strong form efficiency**
  This is the strongest version, which states **all information** in a market, whether **public or private**, is accounted for in a stock price. Not even insider information could give an investor an advantage.

Markets are efficient because:

1. 15,000 or so trained analysts; MBAs, CFAs, Technical PhDs.
2. Work for firms like Merrill, Morgan, Prudential, which have the funds to research.
3. Have similar access to data.
4. Thus, news are reflected in P_0 almost instantaneously.

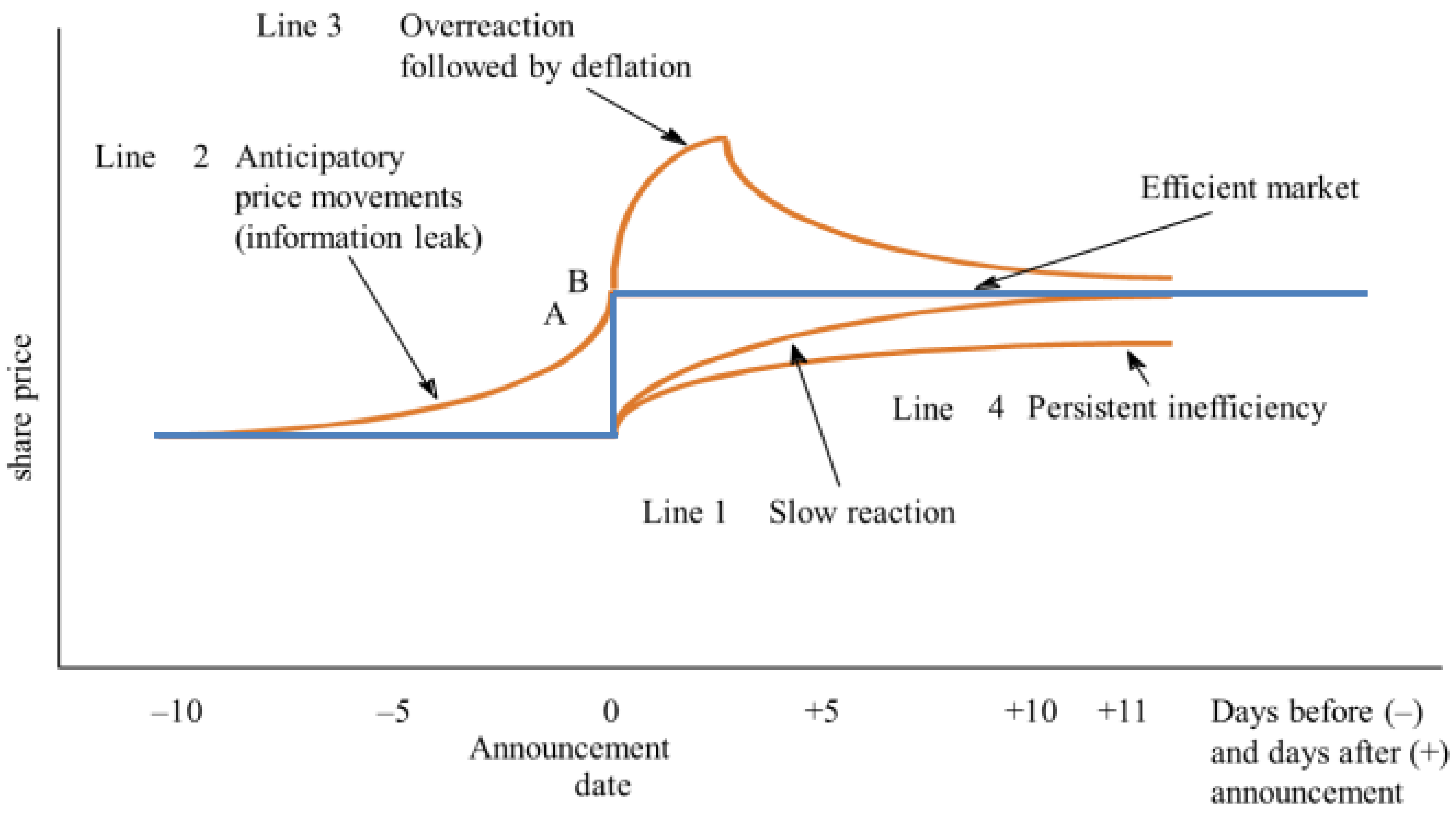
Efficient Market Hypothesis

- Reaction to news.



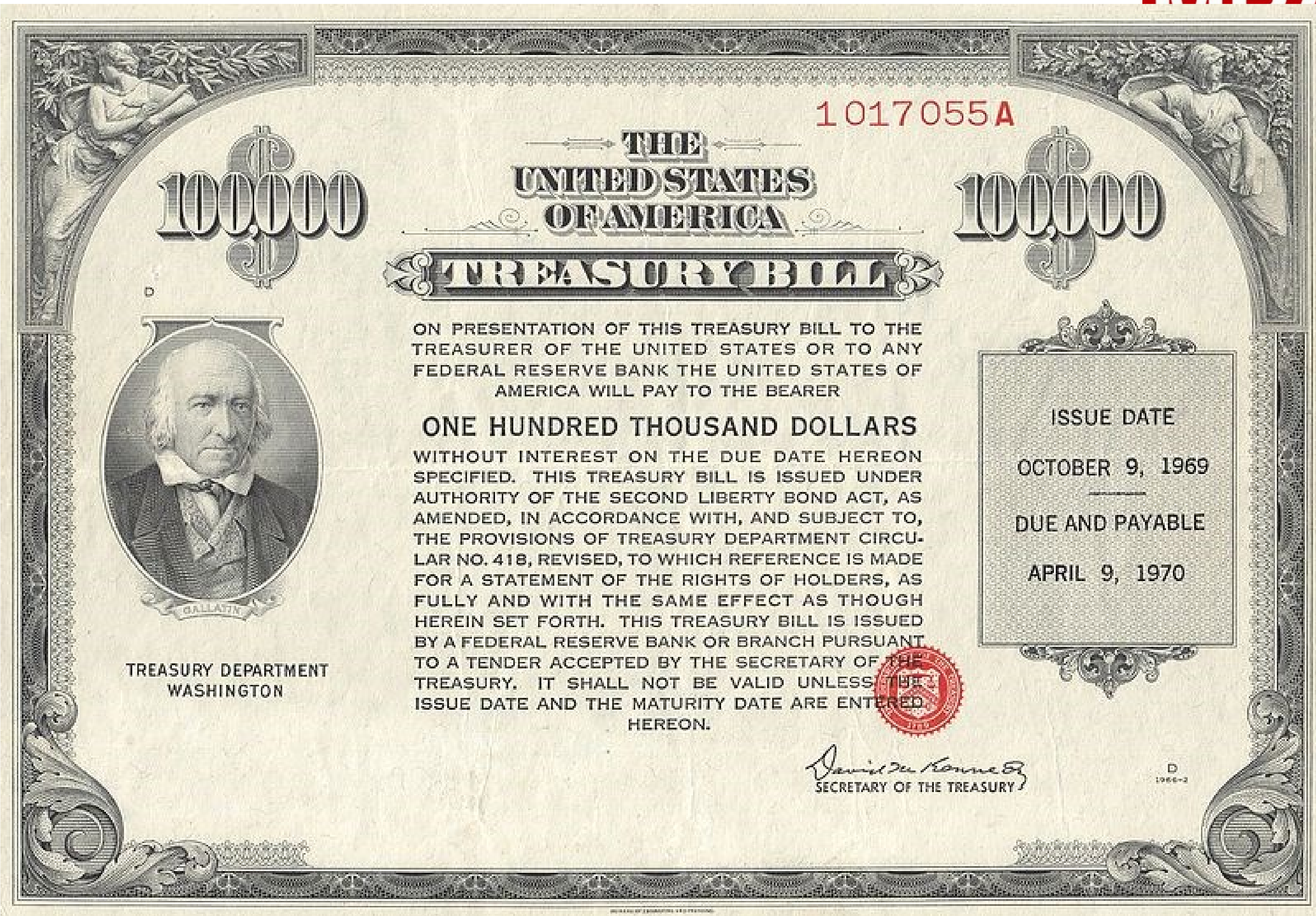
Efficient Market Hypothesis

- Reaction to news.



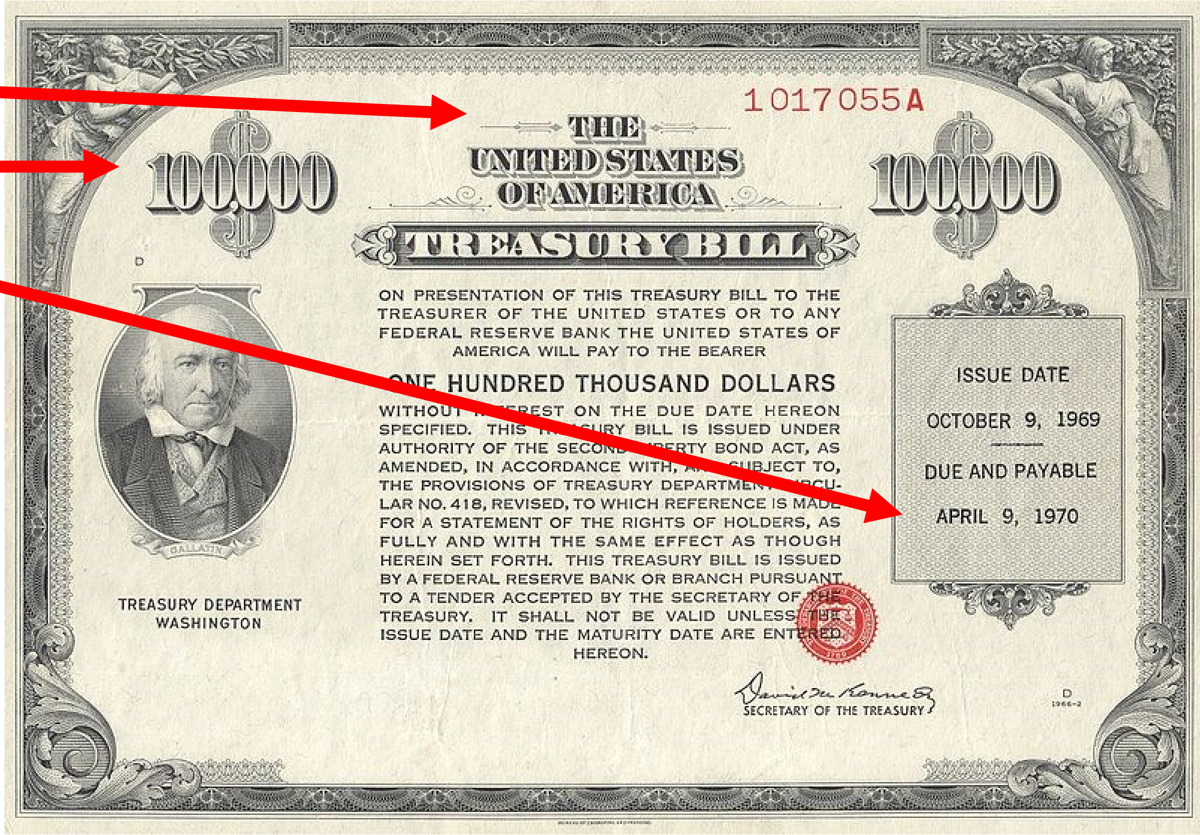
Bond Valuation

Discount Bond



Never change:
- Issuer
- Face value
- Maturity date

Fluctuate:
- Price
- Yield to maturity



Discount or Zero-Coupon Bonds

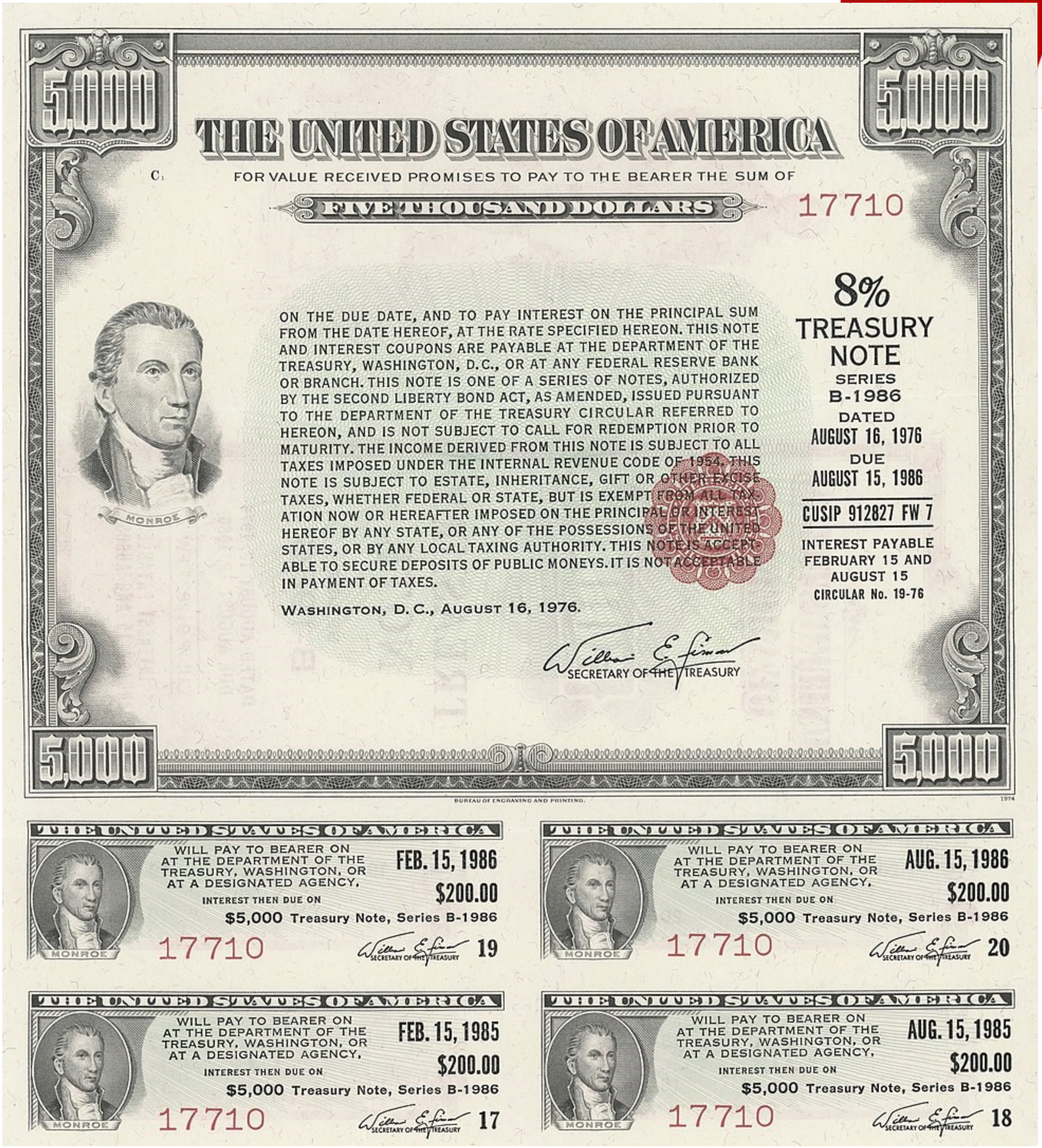
- Discount Bond value:

$$\text{Price} = \text{PV} = \frac{FV}{(1+r)^n}$$

  - PV: present value
  - FV: face value, future value
  - r: rate to maturity, yield, interest rate
  - n: periods to maturity

In Excel =RATE(10,90,-882.22,1000)

Coupon Bond


5,000
THE UNITED STATES OF AMERICA
FOR VALUE RECEIVED PROMISES TO PAY TO THE BEARER THE SUM OF
FIVE THOUSAND DOLLARS
17710
ON THE DUE DATE, AND TO PAY INTEREST ON THE PRINCIPAL SUM FROM THE DATE HEREOF, AT THE RATE SPECIFIED HEREON. THIS NOTE AND INTEREST COUPONS ARE PAYABLE AT THE DEPARTMENT OF THE TREASURY, WASHINGTON, D.C., OR AT ANY FEDERAL RESERVE BANK OR BRANCH. THIS NOTE IS ONE OF A SERIES OF NOTES, AUTHORIZED BY THE SECOND LIBERTY BOND ACT, AS AMENDED, ISSUED PURSUANT TO THE DEPARTMENT OF THE TREASURY CIRCULAR REFERRED TO HEREON, AND IS NOT SUBJECT TO CALL FOR REDEMPTION PRIOR TO MATURITY. THE INCOME DERIVED FROM THIS NOTE IS SUBJECT TO ALL TAXES IMPOSED UNDER THE INTERNAL REVENUE CODE OF 1954. THIS NOTE IS SUBJECT TO ESTATE, INHERITANCE, GIFT OR OTHER EXCISE TAXES, WHETHER FEDERAL OR STATE, BUT IS EXEMPT FROM ALL TAXATION NOW OR HEREAFTER IMPOSED ON THE PRINCIPAL OR INTEREST HEREOF BY ANY STATE, OR ANY OF THE POSSESSIONS OF THE UNITED STATES, OR BY ANY LOCAL TAXING AUTHORITY. THIS NOTE IS ACCEPTABLE TO SECURE DEPOSITS OF PUBLIC MONEYS. IT IS NOT ACCEPTABLE IN PAYMENT OF TAXES.
WASHINGTON, D. C., AUGUST 16, 1976.
SECRETARY OF THE TREASURY
MONROE
8%
TREASURY NOTE
SERIES B-1986
DATED AUGUST 16, 1976
DUE AUGUST 15, 1986
CUSIP 912827 FW 7
INTEREST PAYABLE FEBRUARY 15 AND AUGUST 15
CIRCULAR No. 19-76
THE UNITED STATES OF AMERICA
WILL PAY TO BEARER ON AT THE DEPARTMENT OF THE TREASURY, WASHINGTON, OR AT A DESIGNATED AGENCY,
FEB. 15, 1986
$200.00
INTEREST THEN DUE ON
$5,000 Treasury Note, Series B-1986
17710
19
AUG. 15, 1986
20
FEB. 15, 1985
17
AUG. 15, 1985
18

Bond Valuation

Coupon bond:

$$P = \frac{C}{(1+YTM)} + \frac{C}{(1+YTM)^2} + \ldots + \frac{C}{(1+YTM)^{\nu}} + \frac{F}{(1+YTM)^{\nu}}$$

Alternatively:

$$P = C \times \left[\frac{1 - \frac{1}{(1+YTM)^{\nu}}}{YTM} \right] + \frac{F}{(1+YTM)^{\nu}}$$

Bond Valuation

For the Coupon Bond:

- If **Price** = **FV** → YTM = coupon rate
- If **Price** < **FV** → YTM > coupon rate
- If **Price** > **FV** → YTM < coupon rate

- Why? The price adjusts so that the YTM adapts to interest rates.
- Coupon return + capital gains → YTM = interest rates

Bond:

- **Price** < **FV** → at discount
- **Price** > **FV** → at premium
- **Price** = **FV** → at par

Consol - Perpetuity

DEPARTMENT OF ECONOMICS MBA

Bond Valuation

Perpetual bond – Consol

$$P = \frac{c}{r}$$

- P = price of bond
- c = coupon payment
- r = interest rate

Bond Features

- Bond **Strips**
- **Optionality**: Callable – Putable bonds
  - European → 1
  - Bermudan → > 1
  - American → all
- Convertible → issuer shares
- Exchangeable → other assets
- **Credit Default Swaps** (CDS) – naked CDS

Currency based:

- **Yankee** Bonds: in USD in US by foreigners
- **Kangaroo** Bonds: in AUD in Australia by foreigners
- **Samurai** Bonds: in Yen in Japan by foreigners
- **Eurobond:** in a currency other than the home currency of the country or market in which it is issued
- **Dollar** Bonds: a USD bond outside of the United States

Bond Risk

MBA

1. Credit Default Risk

- ❑ Ratings
- ❑ CDS

S & P	*PD* [%]
AAA	0.02
AA	0.03
A	0.07
BBB	0.18
BB	0.7
B	2.0
CCC	14.0
CC	17.0
C	20.0
D	> 20.0

Moody's Investors & Poor's Agencies.

No	S&P	Moody's	Fitch	Meaning and Color
1	AAA	Aaa	AAA	Prime
2	AA+	Aa1	AA+	High Grade
3	AA	Aa2	AA	
4	AA-	Aa3	AA	
5	A+	A1	A+	Upper Medium Grade
6	A	A2	A	
7	A-	A3	A-	
8	BBB+	Baa1	BBB+	Lower Medium Grade
9	BBB	Baa2	BBB	
10	BBB-	Baa3	BBB-	
11	BB+	Ba1	BB+	Non Investment Grade Speculative
12	BB	Ba2	BB	
13	BB-	Ba3	BB-	
14	B+	B1	B+	Highly Speculative
15	B	B2	B	
16	B-	B3	B-	
17	CCC+	Caa1	CCC+	Substantial Risks
18	CCC	Caa2	CCC	Extremely Speculative

Bond Risk

2. Inflation Risk – inflation linked bonds

3. Liquidity risk

- Ability to convert to cash – sell with minimal loss.

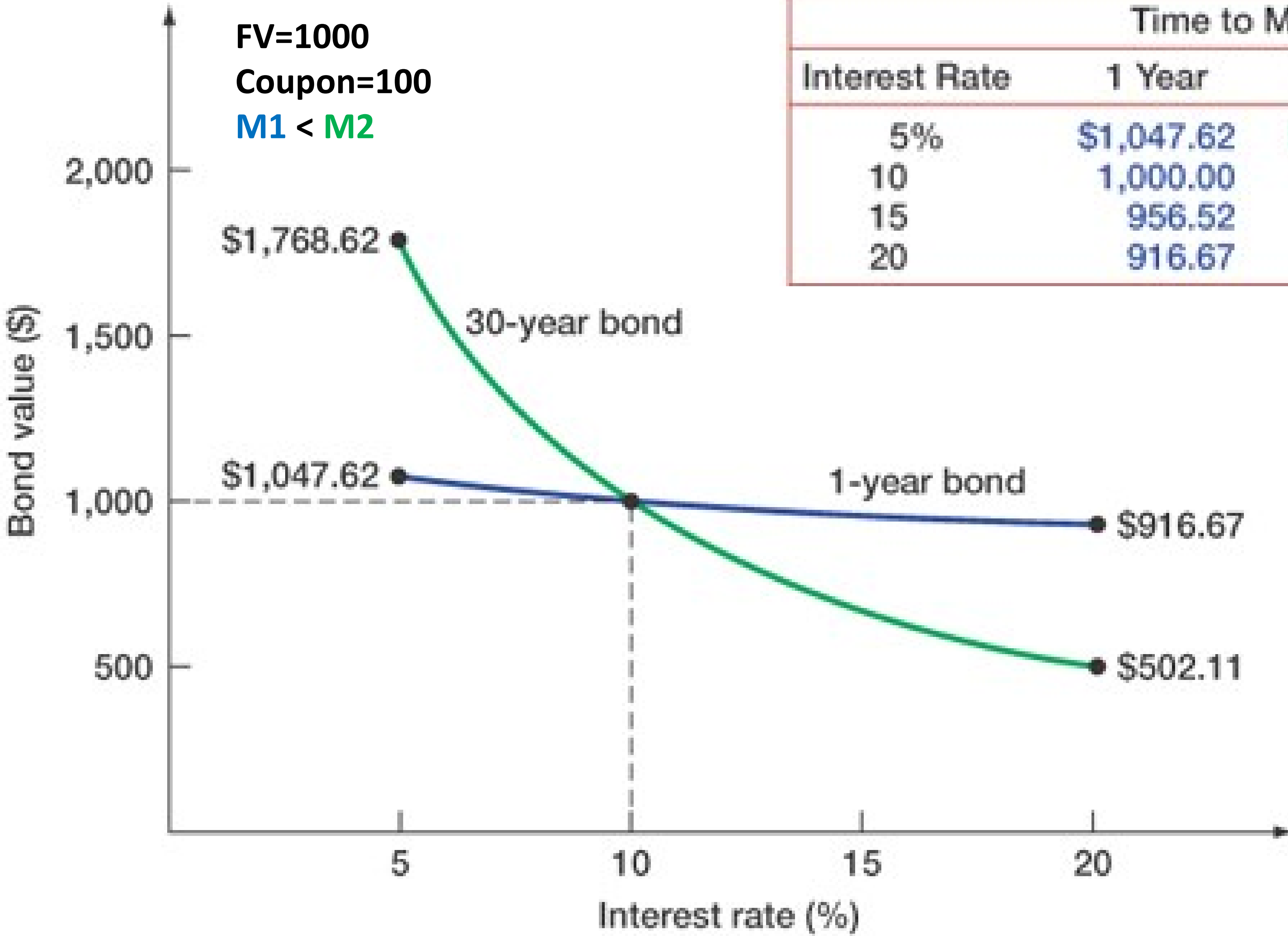
4. Price – Interest Rate Risk

- Change in **price** due to changes in **interest rates**
- There is **no price risk** if **holding period = maturity period**.
  No price risk – P and FV are known.
- **Long-term** bonds have **more price risk** than **short-term bonds.**
  Price needs to adjust more to produce the same return for more years

Bond Properties

FV=1000
Coupon=100
M1 < M2

	Time to Maturity	
Interest Rate	1 Year	30 Years
5%	$1,047.62	$1,768.62
10	1,000.00	1,000.00
15	956.52	671.70
20	916.67	502.11



Bond Risk

2. Inflation Risk – inflation linked bonds

3. Liquidity risk

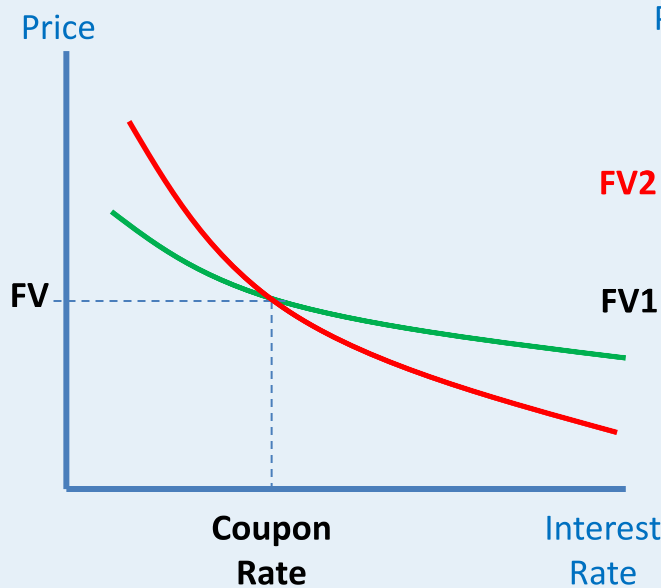
- Ability to convert to cash – sell with minimal loss.

4. Price – Interest Rate Risk

- Change in **price** due to changes in **interest rates**
- There is **no price risk** if **holding period = maturity period**.
  No price risk – P and FV are known.
- **Long-term** bonds have **more price risk** than **short-term bonds.**
  Price needs to adjust more to produce the same return for more years
- **Low coupon rate** bonds have **more price risk** than high coupon rate bonds.
  Their YTM relies more on capital gains than coupon yield.

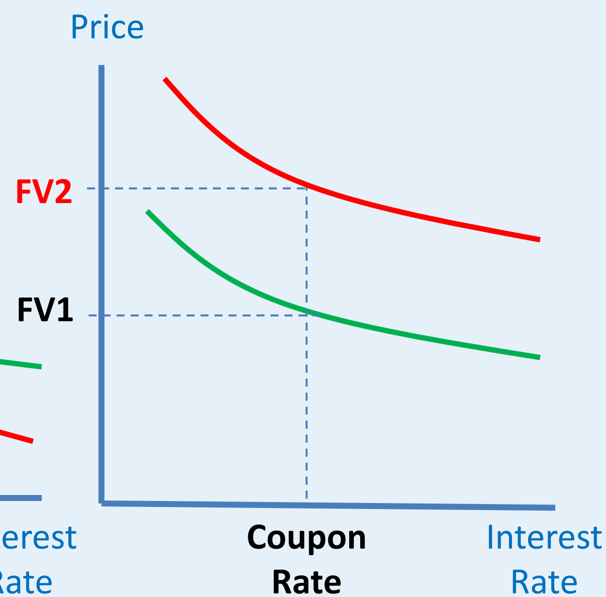
Bond Properties

Difference in Maturity



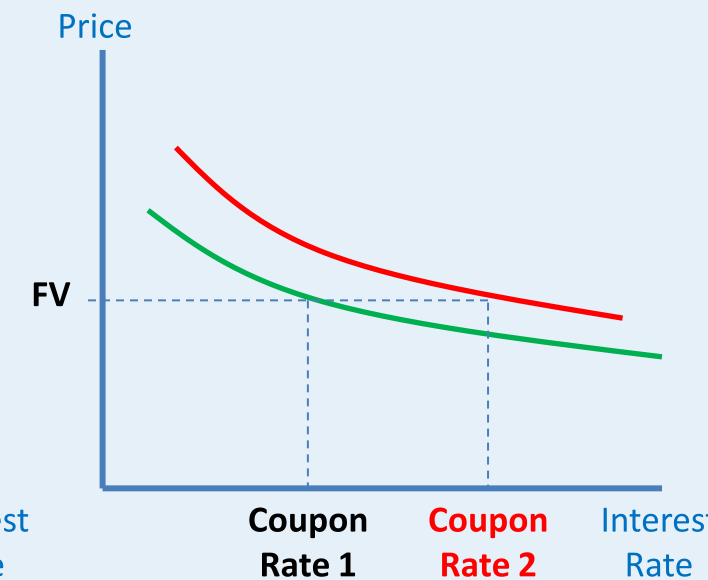
- FV1 = FV2 = 1000
- C1 = C2 = 10%
- M1 = 1 < M2 = 10

Difference in Face Value



- FV1 = 1000 < FV2 = 2000
- C1 = C2 = 10%
- M1 = M2

Difference in Coupon Rate



- FV1 = FV2 = 1000
- C1 = 10% < C2 = 20%
- M1 = M2

Bond Risk

5. Reinvestment Rate Risk

- **Uncertainty** concerning **rates** at which **cash flows** can be **reinvested**
- **Short-term** bonds have **more** reinvestment rate risk than long-term bonds
- **High coupon** rate bonds have **more** reinvestment rate risk than low coupon rate bonds

Clean vs. Dirty Prices

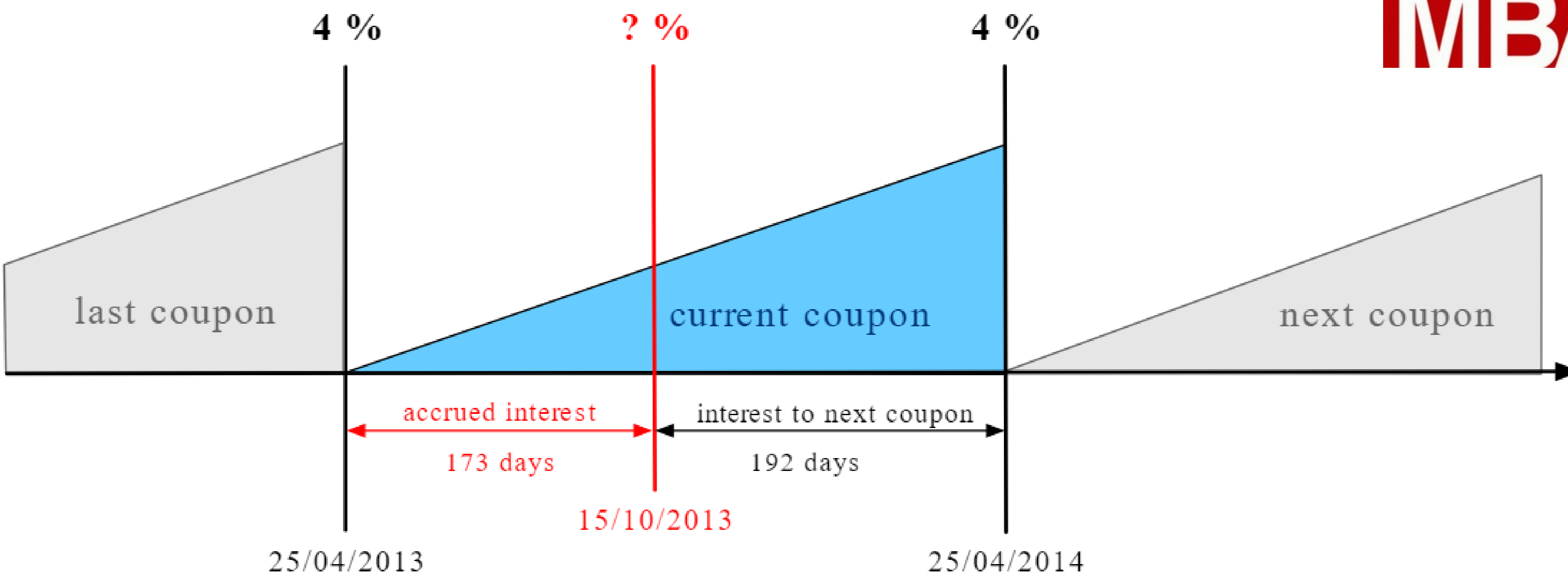
- **Pc = Clean price**: quoted price
- **Pd = Dirty price**: price actually paid

  = Clean price + accrued interest

$$P_d = FV \cdot \frac{C}{P} \cdot \frac{D}{T}$$

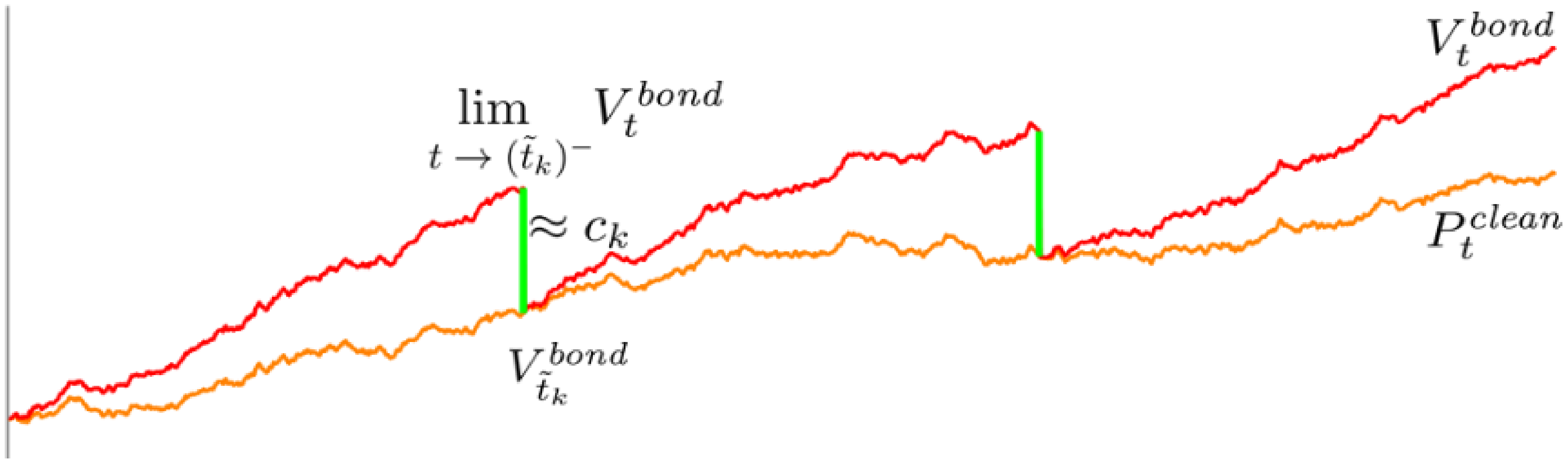
  - FV: Face value
  - C: Coupon rate
  - P: Number of coupon payments made in a year
  - D: Number of days since the last coupon payment
  - T: Number of days between coupon payments

Clean vs. Dirty Prices



Clean vs. Dirty Prices

Actual bond price



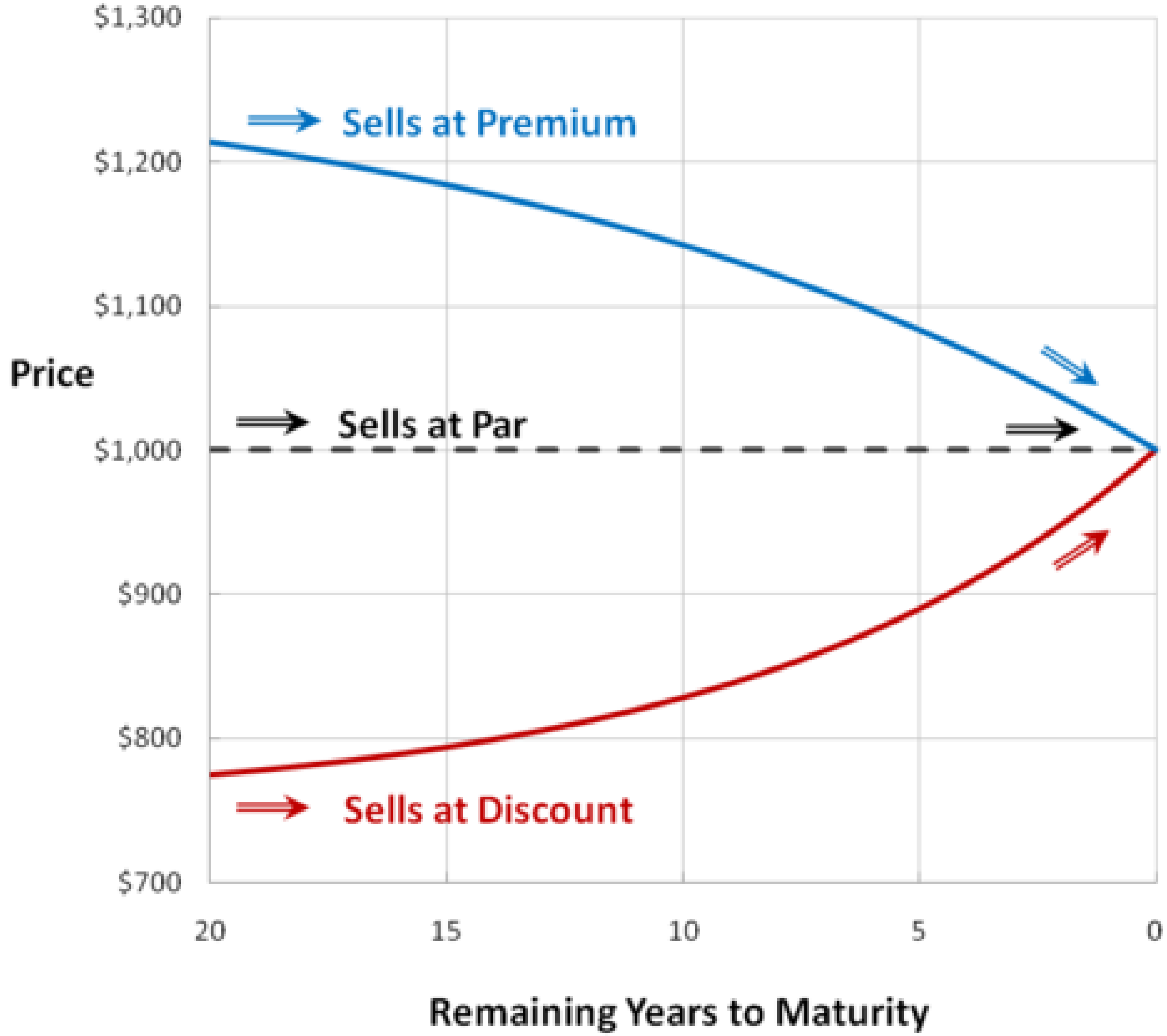
Clean vs. Dirty Prices

Clean price	Dirty price
• Clean price = Quoted percentage of face value	• Dirty price = Clean price + interest accrued
• Fluctuates with interest rates and bond market conditions	• Changes each day that interest accrues
• Usually the quoted price	• Represents true market value
• Used to compare different bonds	• Used to determine total cost of a bond

Excel functions: https://thismatter.com/money/bonds/bond-pricing.htm

Price of Bond over Time

Price of Bond Selling at Discount vs. Premium over Time



Clean vs. Dirty Prices

DEPARTMENT OF ECONOMICS MBA

- Clean price: quoted price
- Dirty price: price actually paid = quoted price plus accrued interest
- Example: Consider a T-bond with a 4% semiannual yield and a clean price of $1,282.50:
  - Number of days since last coupon = 61
  - Number of days in the coupon period = 184
  - Accrued interest = (61/184)(.04*1000) = $13.26
  - Dirty price = $1,282.50 + $13.26 = $1,295.76
- So, you would actually pay $ 1,295.76 for the bond

Basic Functions

Conversions

Annualized returns

$$r_{Annual} = (1 + r_{Period})^{No.of\ Periods} - 1$$

Example 1: Quarterly Returns

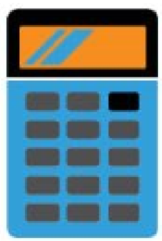
- Let's say we have 5% quarterly returns. Since there are four quarters in a year, the annual returns will be:
- Annual returns = (1+0.05)^4 – 1 = 21.55%

Example 2: Monthly Returns

- Let's say we have 2% monthly returns. Since there are 12 months in a year, the annual returns will be:
- Annual returns = (1+0.02)^12 – 1 = 26.8%

Standard Deviation of an Asset

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$



$$\text{Sample Standard Deviation Formula} = \sqrt{\frac{\sum (X_i - X_m)^2}{(n-1)}}$$

Return of a Portfolio – i assets

$$R_p = \sum\nolimits^{n}_{i=1} w_i\, r_i$$

Standard Deviation of a Portfolio – 2 assets

$$\sigma_p = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$$

$$\sigma_p = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 Cov_{1,2}}$$

$$Cor(R_i, R_j) = \frac{Cov(R_i, R_j)}{\sigma_i \sigma_j}$$