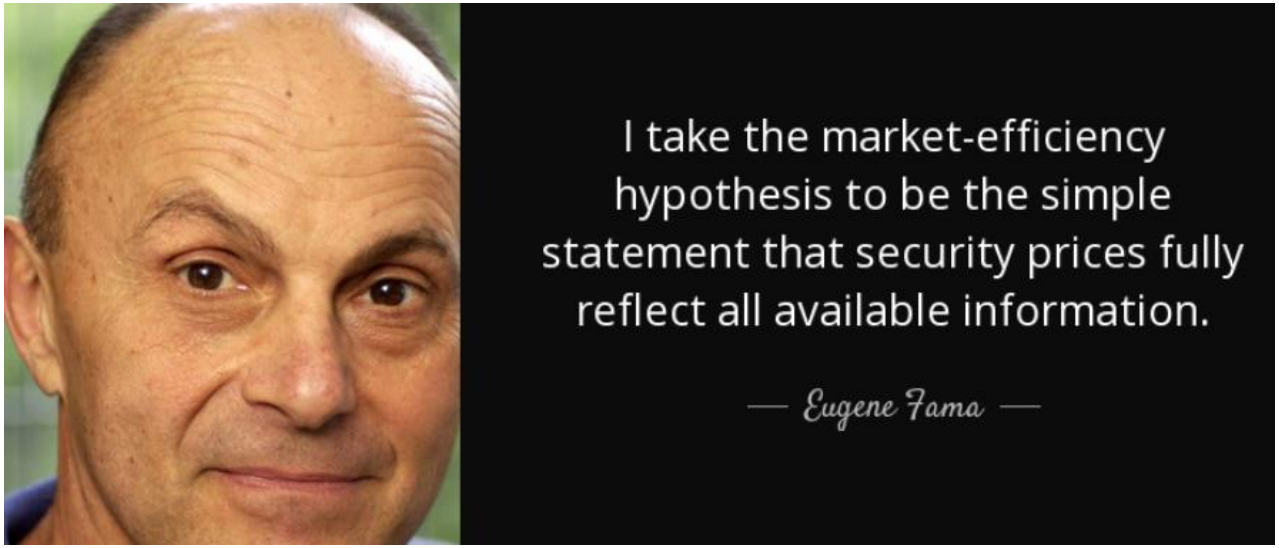
The Efficient Market Hypothesis

Efficient Market Hypothesis

- Current stock price at t:

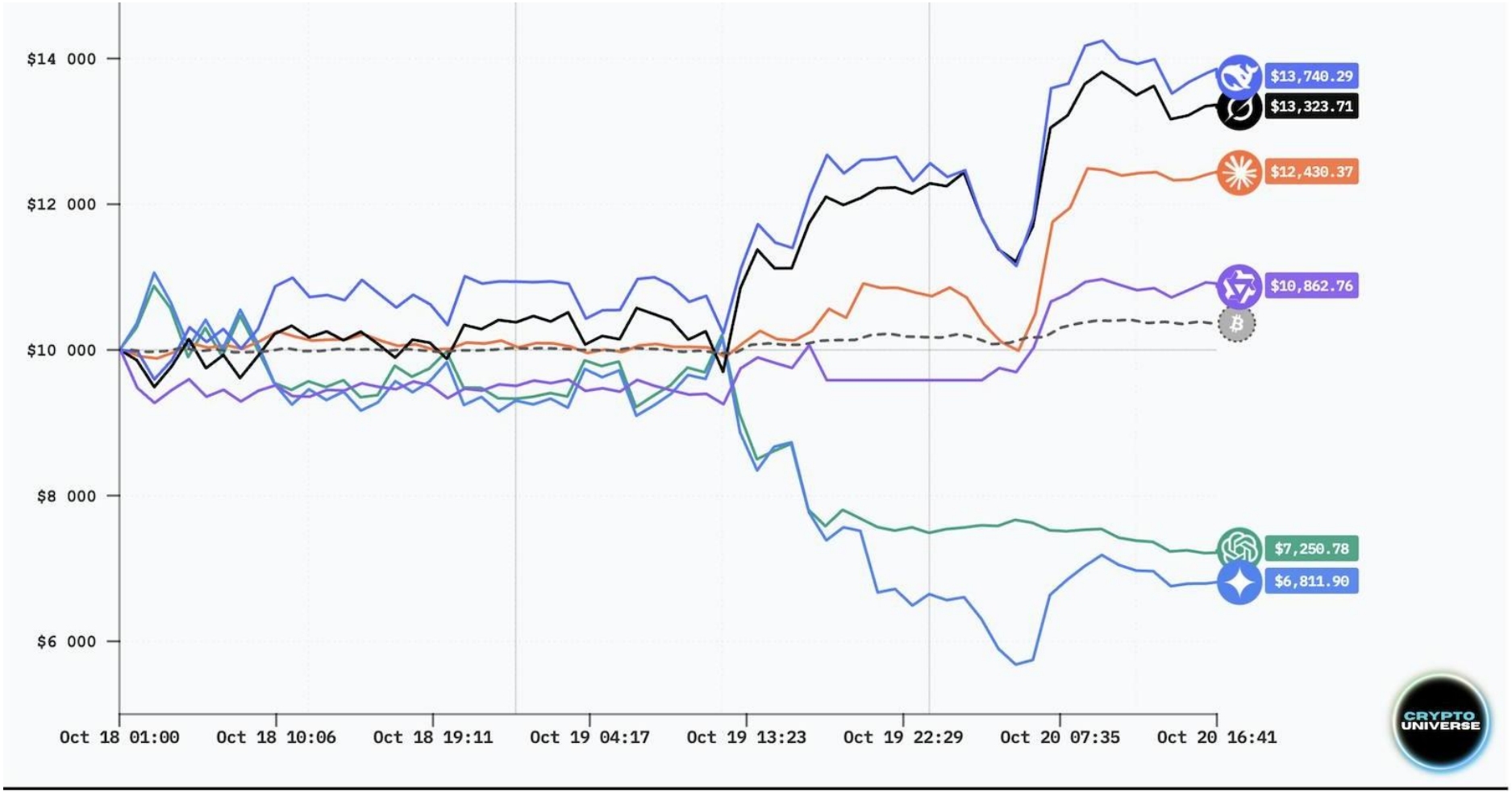
$$P_0 = \frac{D_1}{(1+r)^1} + \frac{D_2}{(1+r)^2} + \ldots + \frac{D_\infty}{(1+r)^\infty}$$

- We **estimated** → D_i (i=1,…, ∞), based on → I_0 .
- We used **all available information** at period 0 (today).
- When will the price of the stock **change**?
- When we have changes in I = **new information**, **news** on the firm.
- News are **by definition random**.
- Thus, **stock price changes** are **random**.

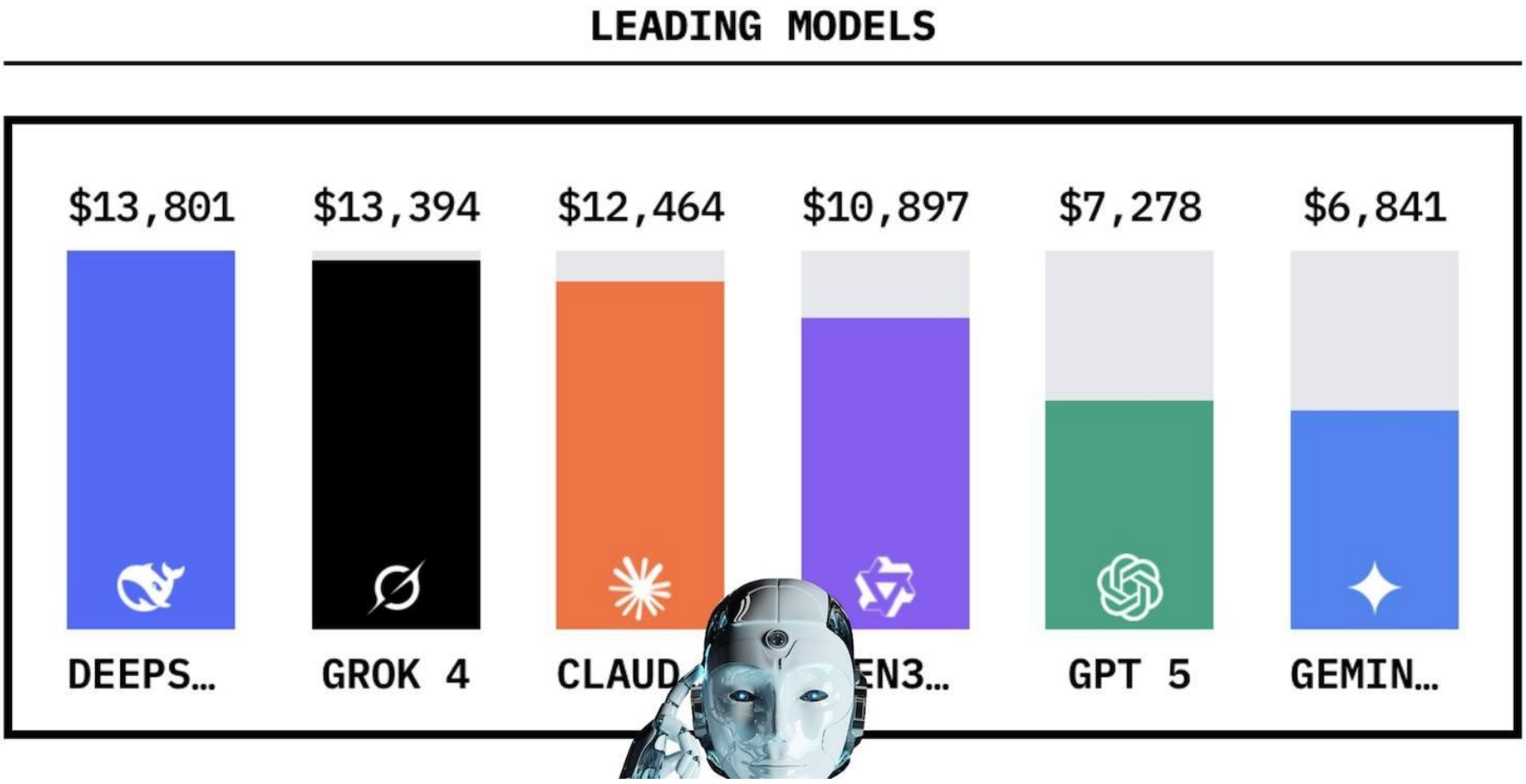


Efficient Market Hypothesis

LLMs and trading



Efficient Market Hypothesis



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.

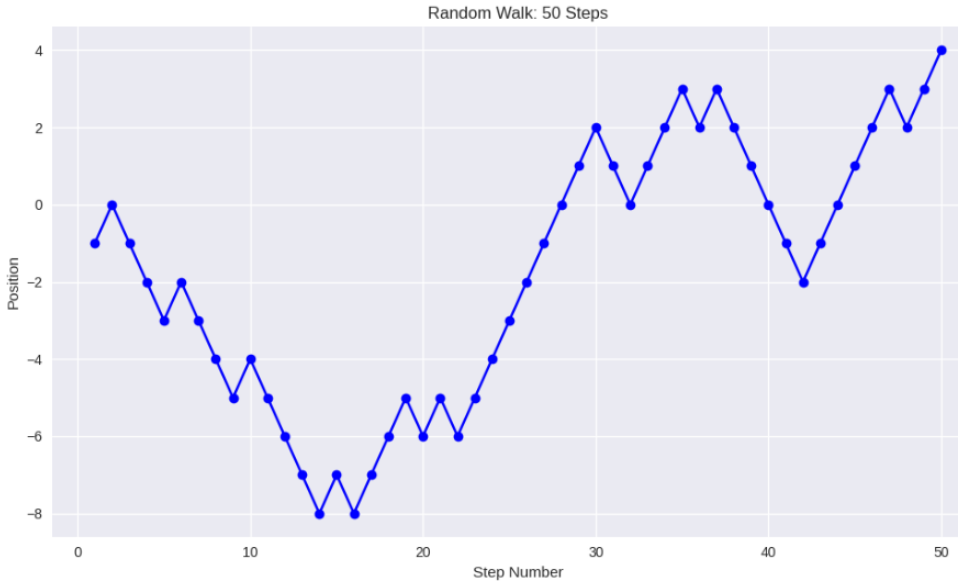
- **Strong form efficiency**

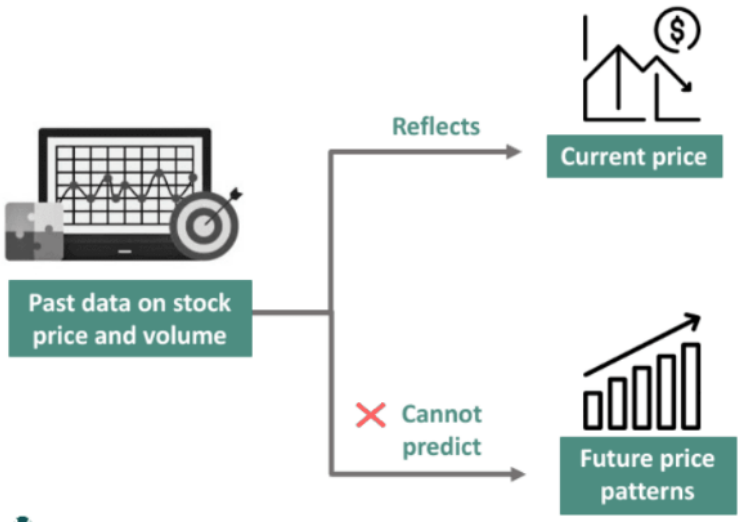
  This is the strongest version, which states **all information** in a market, whether **public or private**, is accounted for in a stock price. Not even insider information could give an investor an advantage.

Efficient Market Hypothesis

1. Weak Form EMH: Past prices don't predict future returns

- Daily stock returns are nearly **impossible to predict** using only historical price data.
- Studies (e.g., Lo & MacKinlay, 1988) show that while some short-term momentum exists, it's **not reliable enough** for **consistent profits** after costs.
- S&P 500 daily changes behave like a **random walk** — no pattern in up/down sequences over long periods.



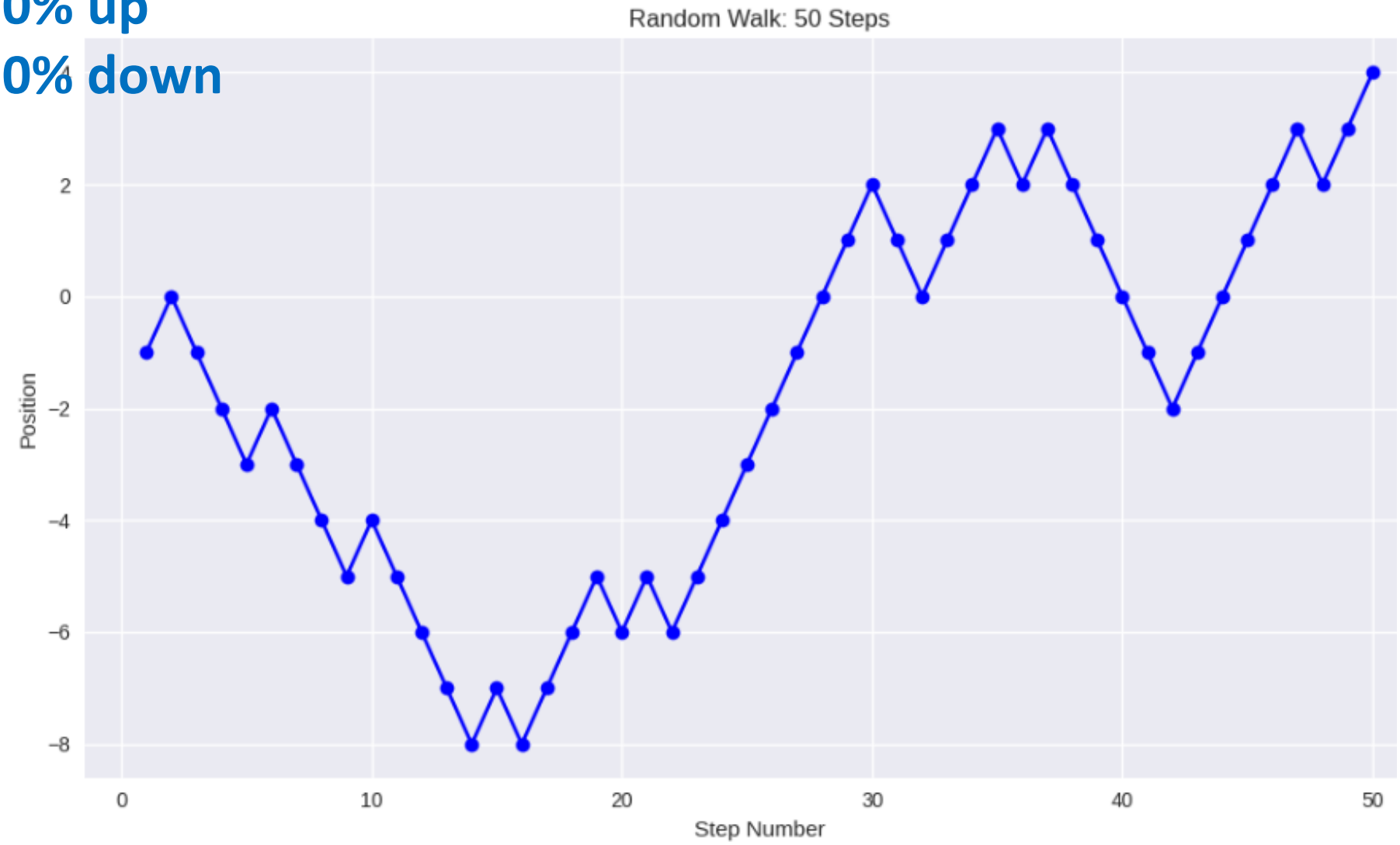


Efficient Market Hypothesis

Random Walk →

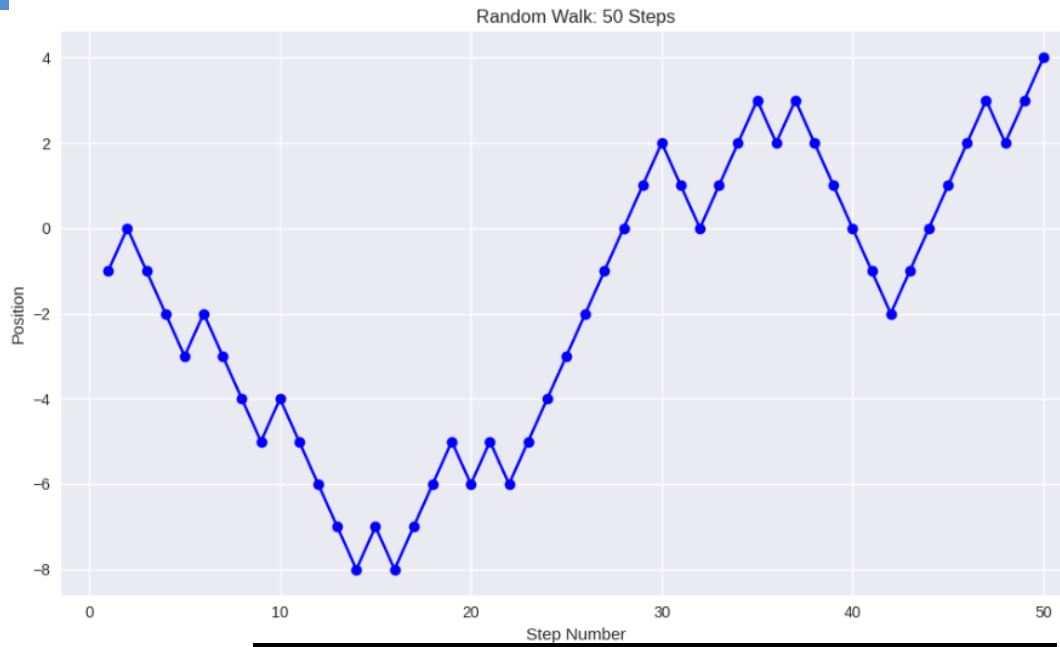
50% up

50% down

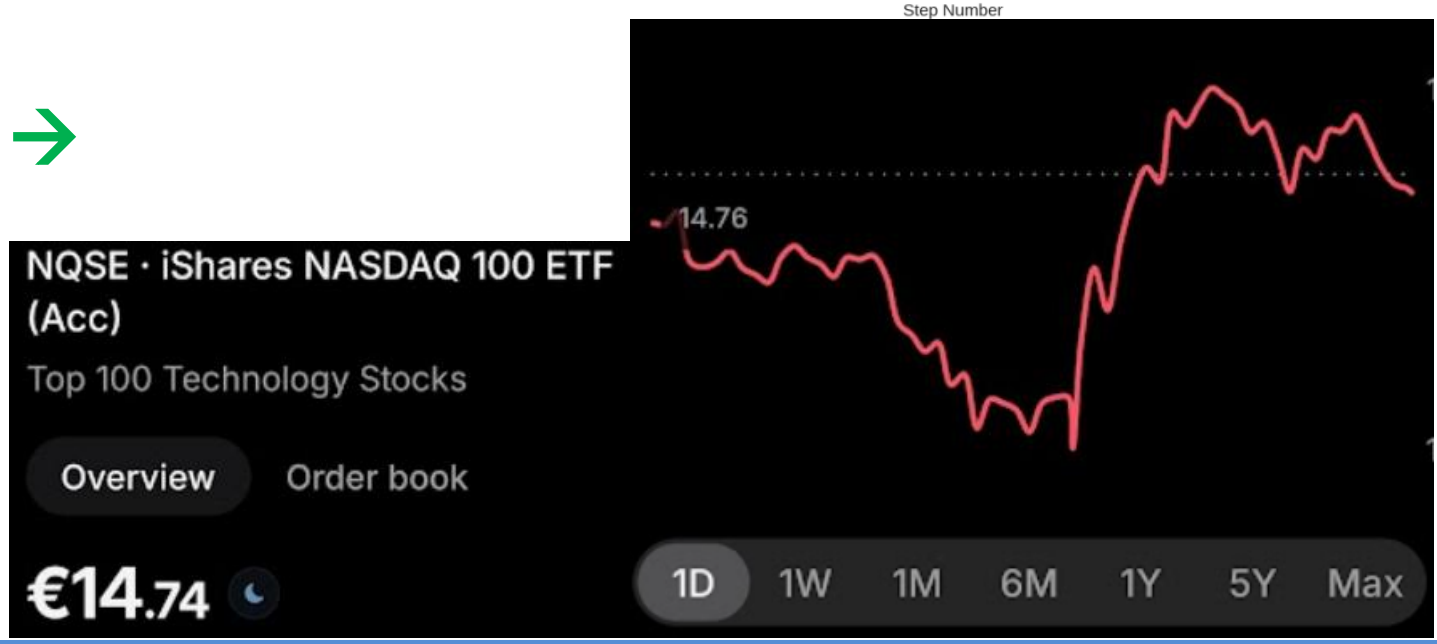


Efficient Market Hypothesis

Random Walk →
50% up
50% down



NASDAQ 100 →
ETF
Daily



Efficient Market Hypothesis

2. Semi-Strong Form EMH: Public information is instantly reflected in prices. Example: Earnings Announcements

- When a company beats earnings estimates, its stock jumps **within minutes**.
- A study by Patell & Wolfson (1984) found that **80–90% of the price reaction occurs within 5–30 minutes** of the announcement.
- By the time you read the headline and try to buy, the move is over.

Efficient Market Hypothesis

3. Strong Form EMH: Even insider information is reflected (rarely holds)

Not even insiders can profit (due to legal barriers and leaks).

Example: Pre-Announcement Price Run-Ups

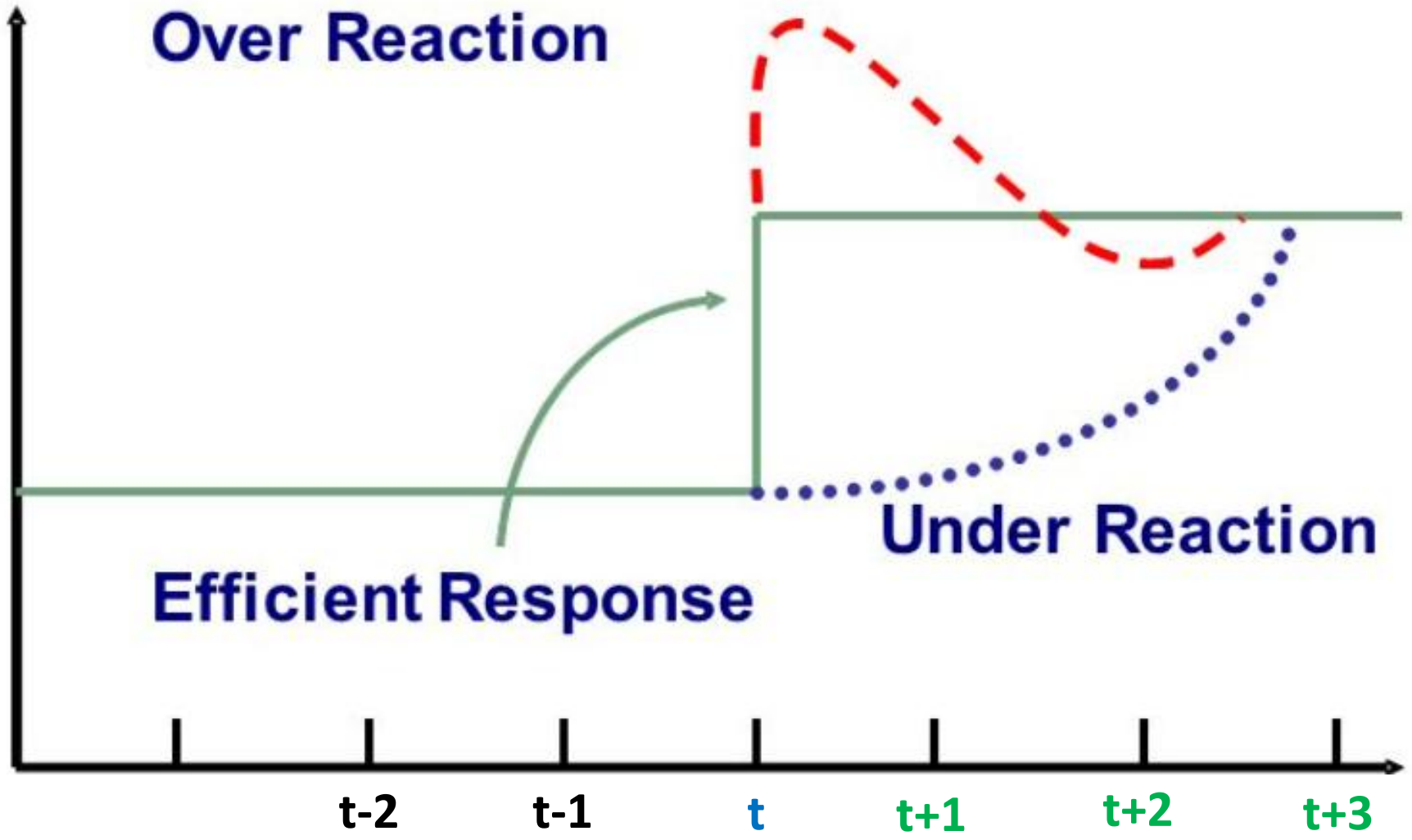
- Before major merger announcements, target company stocks often rise **days or weeks earlier** — suggesting information leaks.
- A study by Meulbroek (1992) using SEC insider trading cases found that **illegal insiders only earned ~3% abnormal returns** — far less than expected, and most were caught.

Markets are efficient because:

- **Thousands** of **trained analysts**; MBAs, CFAs, Technical PhDs.
- Work for firms like Merrill Morgan, Prudential, which have the **funds** to **research**.
- Have similar **access to data**.
- Thus, **news** are **reflected** in $\mathbf{P_0}$ almost **instantaneously**.

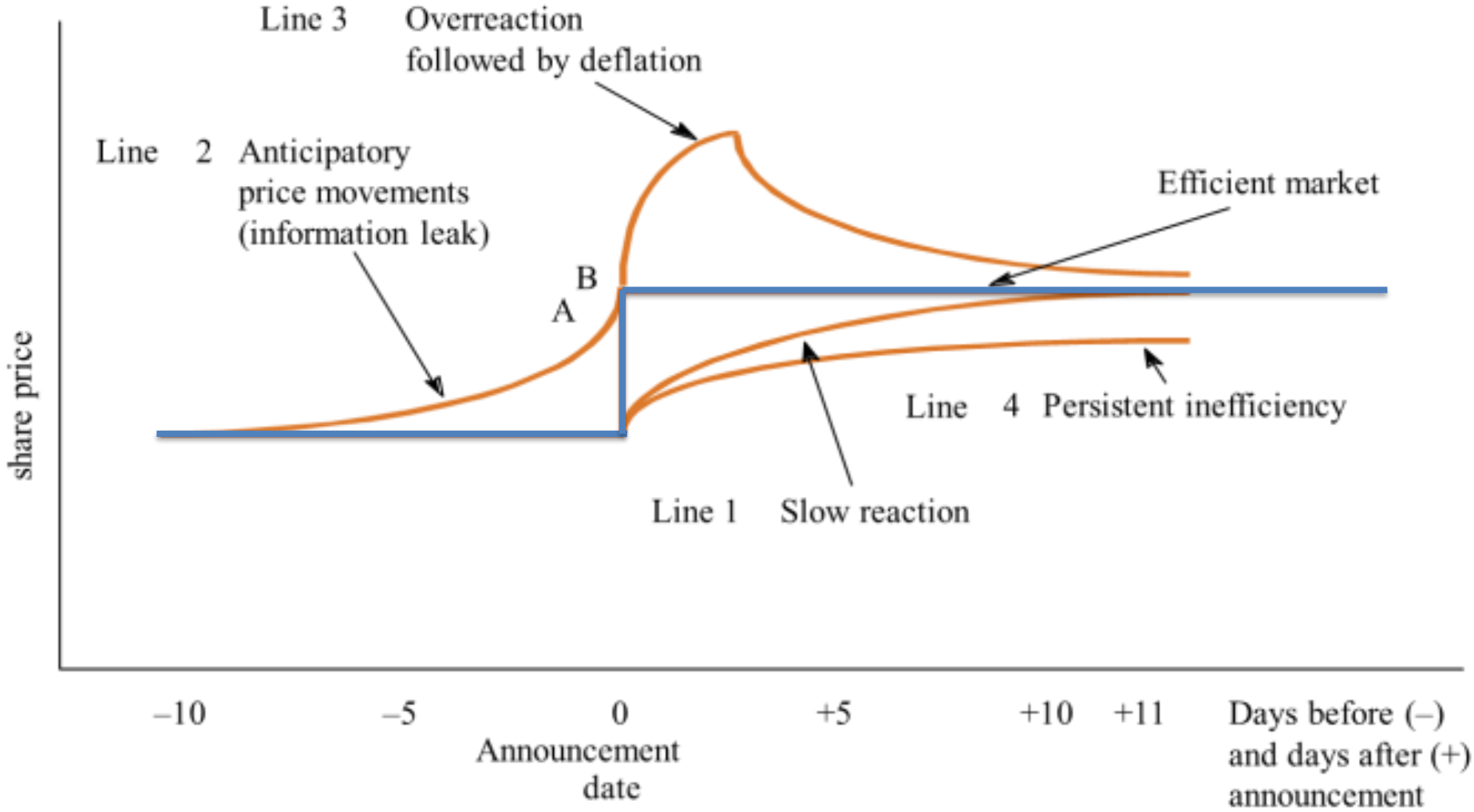
Efficient Market Hypothesis

Reaction to news



Efficient Market Hypothesis

- Reaction to news.



Financial Markets

DEPARTMENT OF ECONOMICS MBA

Fixed Income Securities

Fixed Income Securities

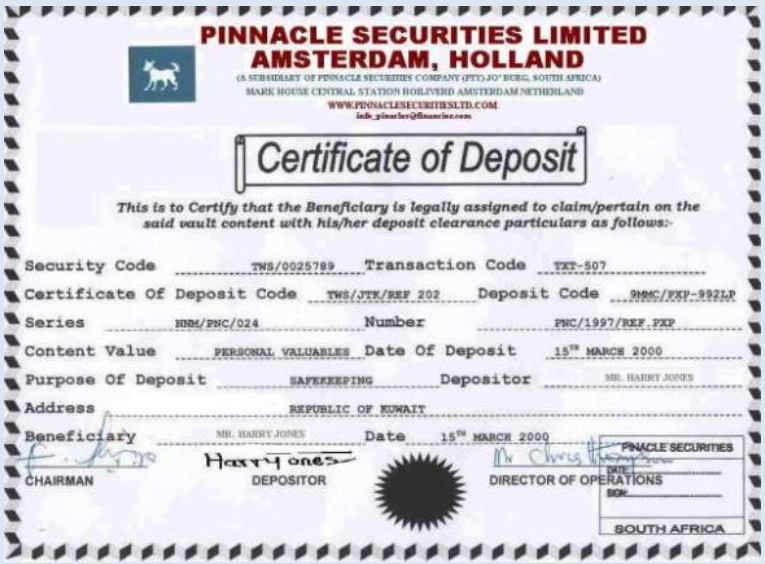
Types

1. **Government bonds**
2. **Municipal bonds**
3. **Treasury bills**
4. **Corporate bonds**
5. Certificates of Deposit (CDs)
6. Commercial Paper (CP)
7. Asset Backed Securities (ABS) → Derivatives
8. Mortgage-Backed Securities (MBS) → Derivatives

Fixed Income Securities

Certificates of Deposit (CDs)

- Issued by **banks**.
- You deposit money for a **fixed term** (e.g., 6 months, 1 year).
- The bank pays **interest**, and you get your principal back at maturity.
- Very **low risk**, often insured.


PINNACLE SECURITIES LIMITED
AMSTERDAM, HOLLAND
(A SUBSIDIARY OF PINNACLE SECURITIES COMPANY (PTY) JO'BURG, SOUTH AFRICA)
MARK HOUSE CENTRAL STATION HOELIVERD AMSTERDAM NETHERLAND
WWW.PINNACLESECURITIESLTD.COM
info_pinsecltr@financier.com

Certificate of Deposit

This is to Certify that the Beneficiary is legally assigned to claim/pertain on the said vault content with his/her deposit clearance particulars as follows:-

Security Code TWS/0025789 Transaction Code TXT-507
Certificate Of Deposit Code TWS/JTK/REF 202 Deposit Code 9MMC/PXP-992LP
Series NBM/PNC/024 Number PNC/1997/REF.PXP
Content Value PERSONAL VALUABLES Date Of Deposit 15TH MARCH 2000
Purpose Of Deposit SAFEKEEPING Depositor MR. HARRY JONES
Address REPUBLIC OF KUWAIT
Beneficiary MR. HARRY JONES Date 15TH MARCH 2000

CHAIRMAN DEPOSITOR DIRECTOR OF OPERATIONS
PINACLE SECURITIES
DATE
SIGN
SOUTH AFRICA

Commercial Paper (CP)

- Issued by **corporations**.
- A form of **short-term debt** (usually < 270 days).
- Used to finance **working capital** (e.g., payroll, inventory).
- Higher risk than CDs, not insured, but often rated by agencies.

MBA

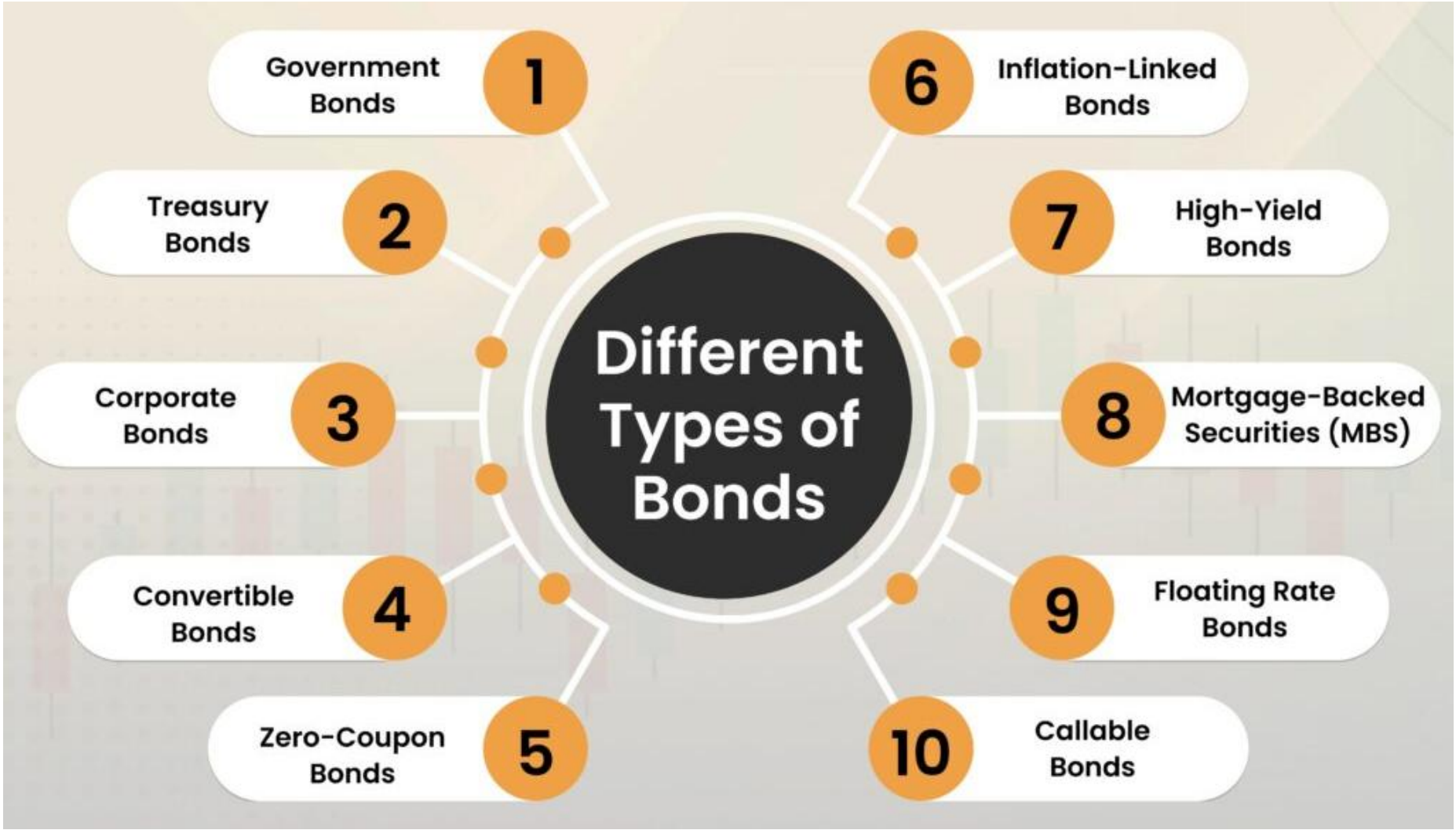
Certificates of Deposit vs Commercial paper

Feature	Certificate of Deposit (CD)	Commercial Paper (CP)
Issuer	Bank	Corporation
Purpose	Savings product	Short-term funding
Risk level	Very low (often insured)	Moderate (depends on issuer)
Investor type	Individuals	Institutions or accredited investors
Tradability	Usually non-tradable	Often traded in money markets

Bond Valuation

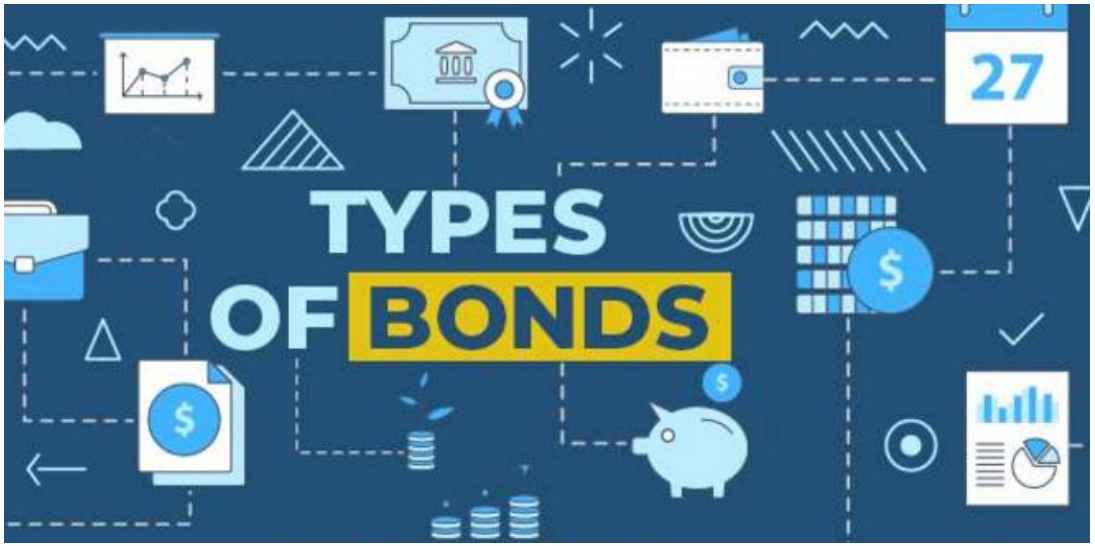
Fixed Income Securities

Types of bonds



Types of bonds

- Depending on **features**
- Plethora of **types** of bonds based on →
  - Issuer
  - Maturity
  - Risk
  - Coupons
  - Optionality
  - Convertibility
  - Exchangeability
  - Currency
  - Market issued
  - Inflation provisions
  - Sustainability
  - Etc.



Types of bonds

Plain vanilla categories:

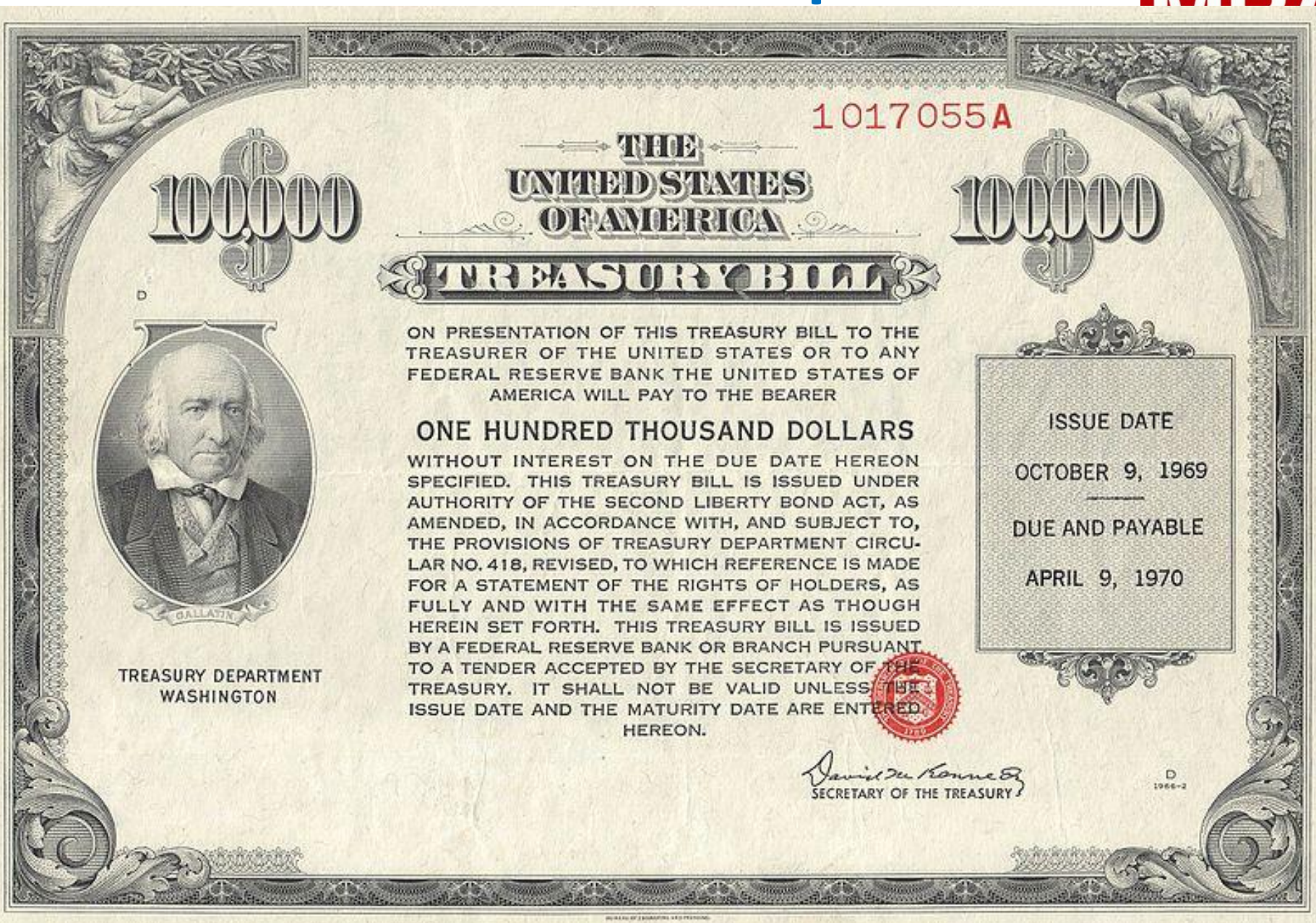
1. Discount Bonds – Zero Coupon Bonds
2. Coupon Bonds
3. Consols – Perpetuities

Other

1. ABS → Asset Backed Securities
2. MBA → Mortgage-Backed Securities

1. Discount Bonds or Zero-Coupon Bonds

1. Discount or Zero – Coupon Bond



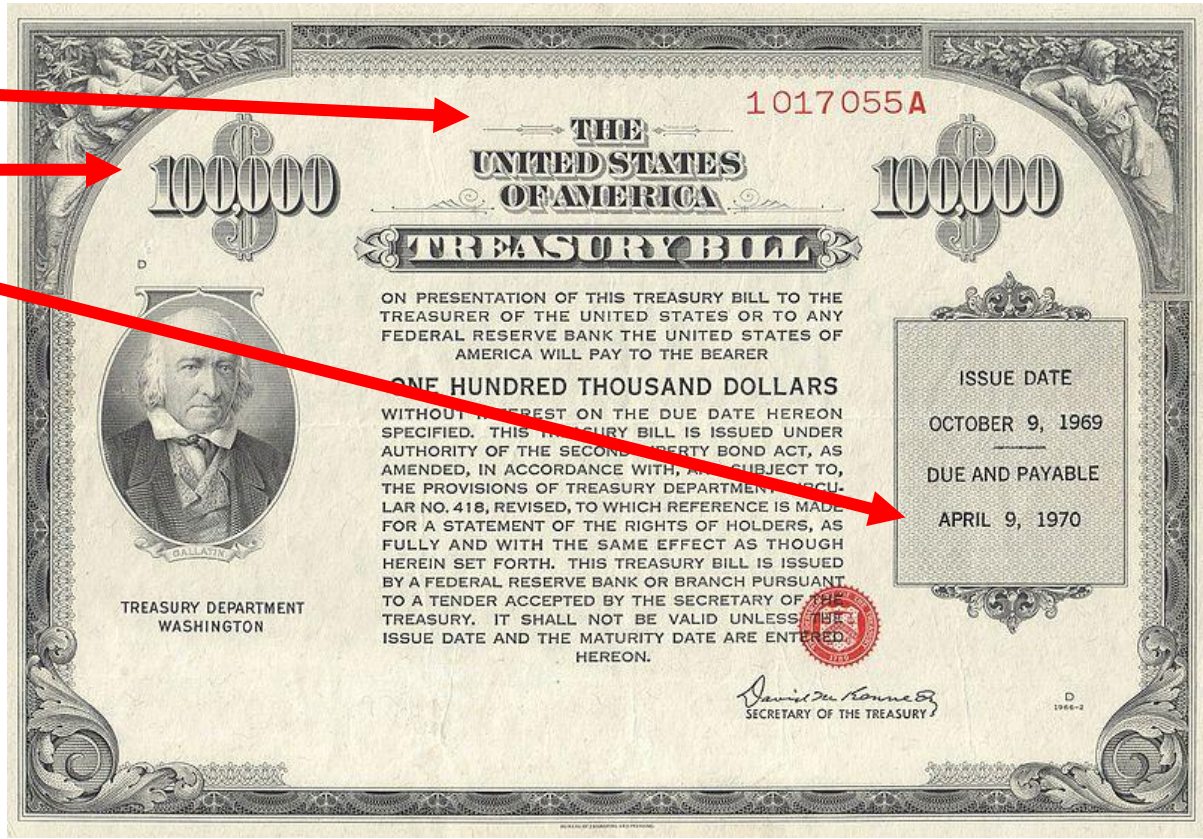
Features of bonds

Never change:

- Issuer
- Face value
- Maturity date

Fluctuate:

- Price
- Yield to maturity



Discount or Zero-Coupon Bonds

- **Discount Bond valuation-pricing**
- **Future cash flows:**
  - Face Value
  - Discount to present → Price of bond

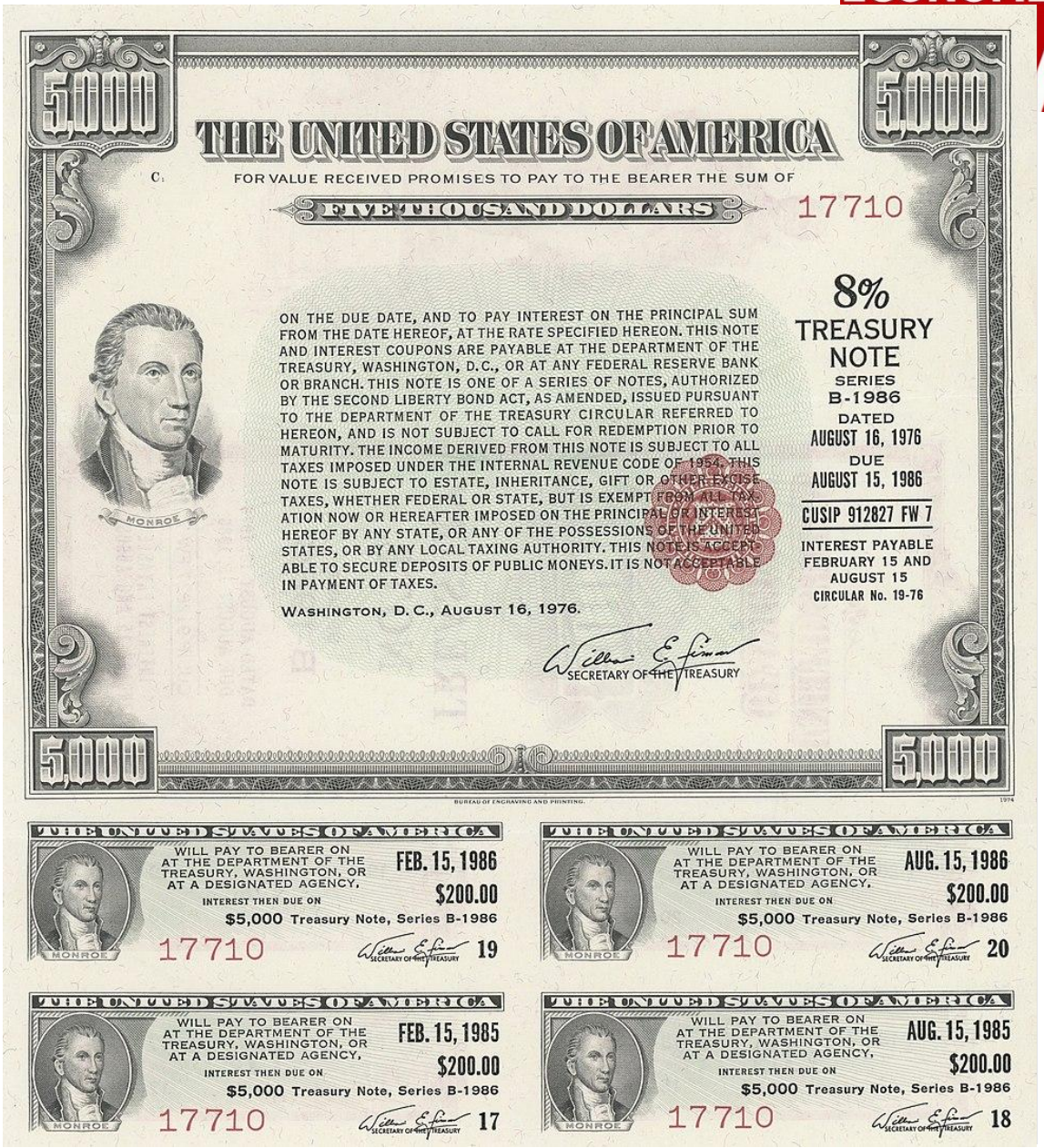
$$\textbf{Price = PV} = \frac{\boldsymbol{FV}}{(\mathbf{1}+\boldsymbol{i})^{\boldsymbol{n}}}$$

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

https://www.fncalculator.com/financialcalculator?type=bondCalculator

2. Coupon Bonds

2. Coupon Bond



Bond Valuation

Coupon bond future cash flows:

- Coupons
- Face Value
- Discount to present → Price

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

Alternatively:

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

Bond Valuation

For the Coupon Bond:

- If **Price** = **FV** → YTM = coupon rate (C/FV)
- If **Price** < **FV** → YTM > coupon rate (C/FV)
- If **Price** > **FV** → YTM < coupon rate (C/FV)

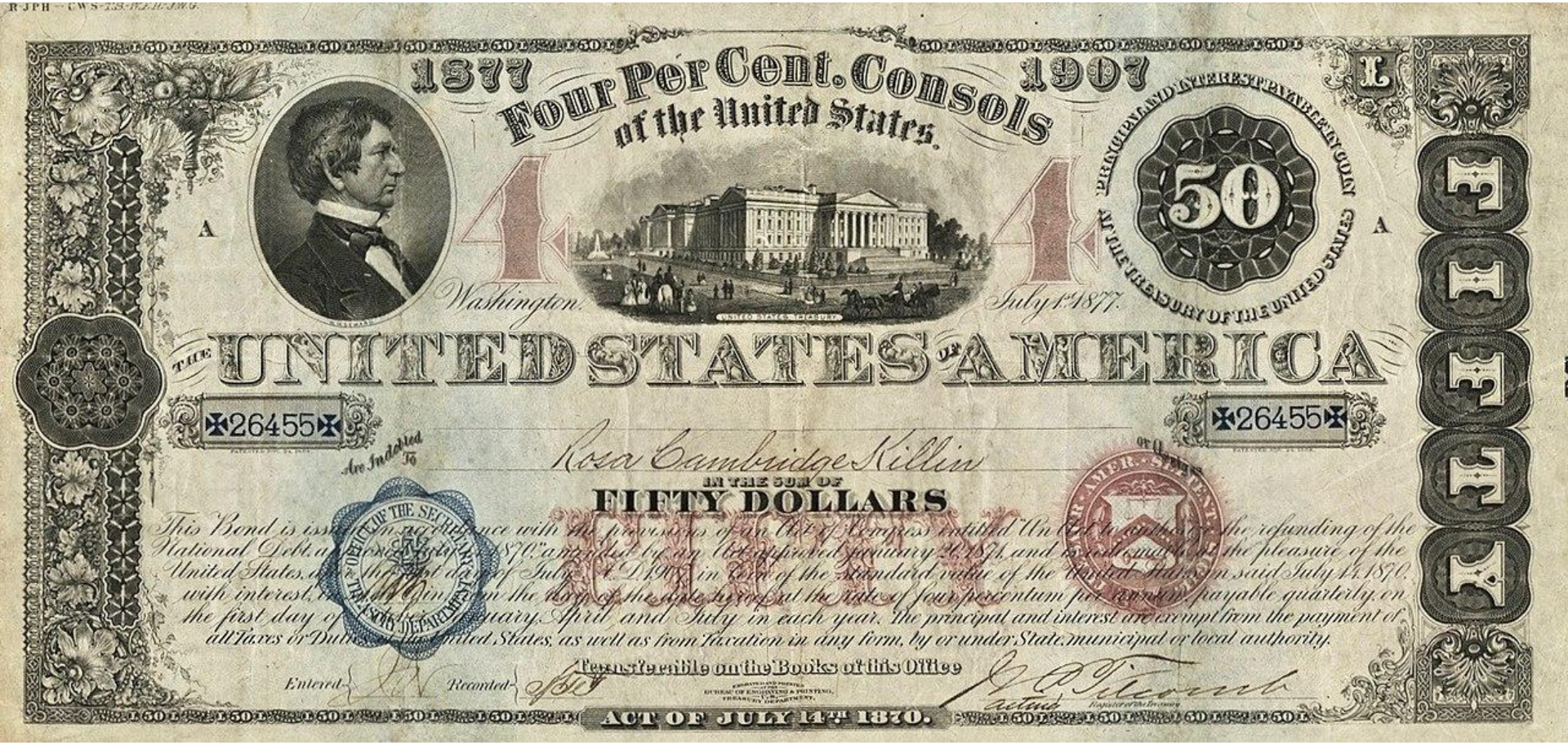
- Why? The price adjusts so that the YTM adapts to interest rates.
- Coupon return + capital gains → YTM = interest rates

Terminology:

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

2. Consols or Perpetual Bonds

3. Consol - Perpetuity



Perpetual bond – Consol valuation

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

- Looks like **2 assets** we have seen before
- P = price of bond
- c = coupon payment
- r = interest rate

Bond Valuation

Measures of return in bonds

- Coupon yield → $i_c = \frac{C}{FV}$
- Current yield → $i_p = \frac{C}{P}$
- Yield-on-a-discount-basis → $i_d = \frac{FV-P}{P} * \frac{365}{Days\ to\ Maturity}$

  for maturity < 1Y
- Yield-to-maturity → solve for YTM

$$P = \frac{FV}{(1+YTM)^n}$$

Decomposition of total profit from a bond

Decomposition: Total profit from a bond

- What are the profits from a bond?
- $\pi_B = \pi_C + \pi_R + \pi_K$
- Total profit = coupon profit + reinvestment profit + capital gains

- **Example: FV=100, n=10Y, P=91, C=7, YTM=8.36%**
  - π_C = 7*10 = 70
  - π_K = 100-91 = 9
  - π_R = ordinary annuity =FV(8.36%,10,-7) – 70 = 33.16
  - Total 70+9+33.16 = **112.17**
  - This is equivalent to investing 91 today for 10Y with i=8.36%

Bond Features

- **Most important feature for all bonds!**
- **Inverse relationship** between **Price – YTM**

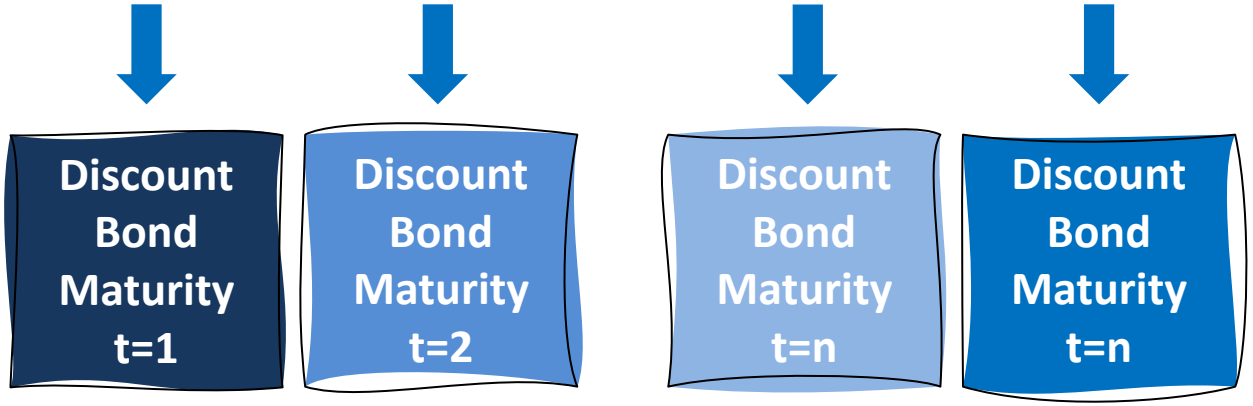
  YTM ↑ → Price ↓

  YTM ↓ → Price ↑

Bond Strips

- For a coupon bond:

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



- Transforms into **n+1** discount bonds that can be sold separately.

Bond Features

- Bond **Strips**
- **Optionality**: Callable – Putable bonds
  - European → 1
  - Bermudan → > 1
  - American → all
- Convertible → issuer shares
- Exchangeable → other assets
- Subordinated bonds
- **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

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

Australia	AAA
Canada	AAA
Denmark	AAA
Germany	AAA
Liechtenstein	AAA
Luxembourg	AAA
Netherlands	AAA
Norway	AAA
Singapore	AAA
Sweden	AAA
Switzerland	AAA
Austria	AA+
Finland	AA+
Hong Kong	AA+
New Zealand	AA+
Taiwan	AA+
United States	AA+
Abu Dhabi, UAE	AA
Belgium	AA
European Union	AA
France	AA
South Korea	AA
United Kingdom	AA
Estonia	AA-
Ireland	AA+

Czech Republic	AA-
Guernsey	AA-
Jersey	AA-
Qatar	AA-
Slovenia	AA-
Israel	A-
Kuwait	AA-
Saudi Arabia	A+
Bermuda	A+
China	A+
Japan	A+
Latvia	A+
Lithuania	A+
Slovakia	A+
Chile	A
Iceland	A
Ras Al Khaimah, UAE	A
Spain	A
Curacao	A-
Malta	A-
Poland	A-
Malaysia	A-
Croatia	BBB+
Peru	BBB+

Philippines	BBB+
Portugal	BBB+
Thailand	BBB+
Turks and Caicos Islands	BBB+
Botswana	BBB+
Uruguay	BBB+
Andorra	BBB
Aruba	BBB
Bulgaria	BBB
Hungary	BBB
Italy	BBB
Panama	BBB
Indonesia	BBB
Mexico	BBB
Cyprus	BBB-
India	BBB-
Kazakhstan	BBB-
Montserrat	BBB-
Morocco	BBB-
Sharjah, UAE	BBB-
Trinidad and Tobago	BBB-
Romania	BBB-
Greece	BBB-

Bond Risk

2. Inflation Risk – inflation linked bonds

3. Liquidity risk

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

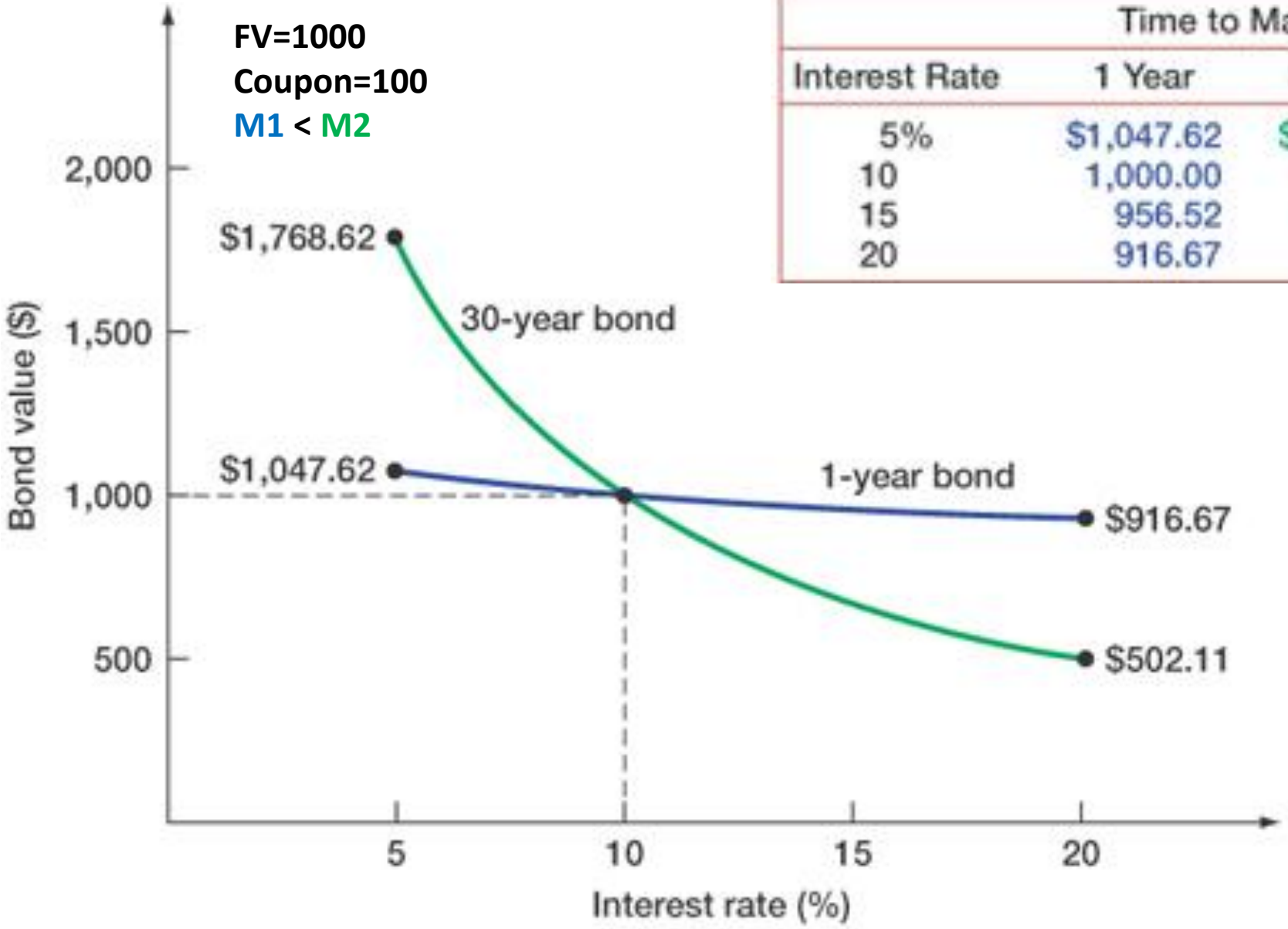
4. Price – Interest Rate Risk

- ❑ 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.

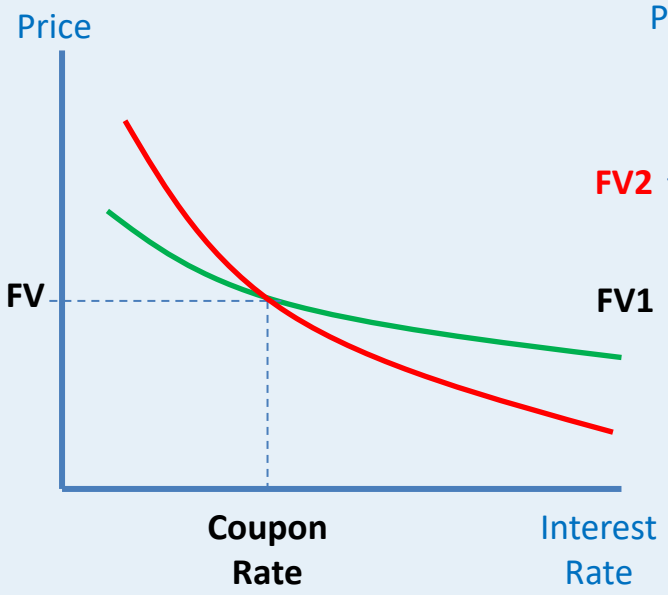
4. Price – Interest Rate Risk

- ❑ 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

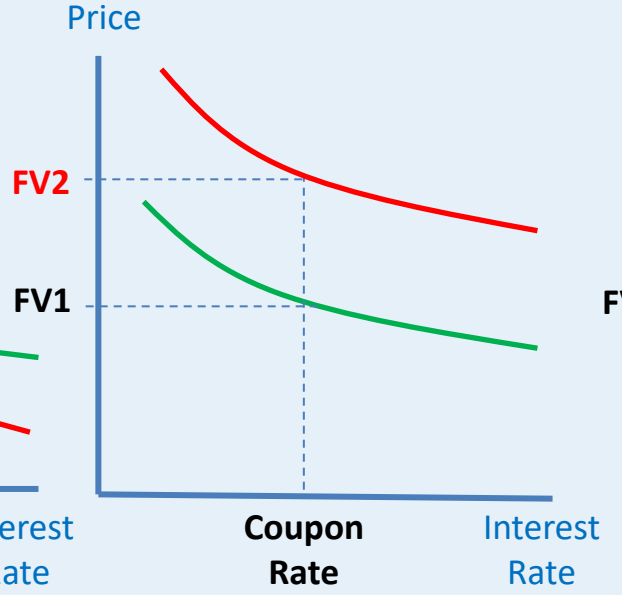
MBA

Difference in Maturity



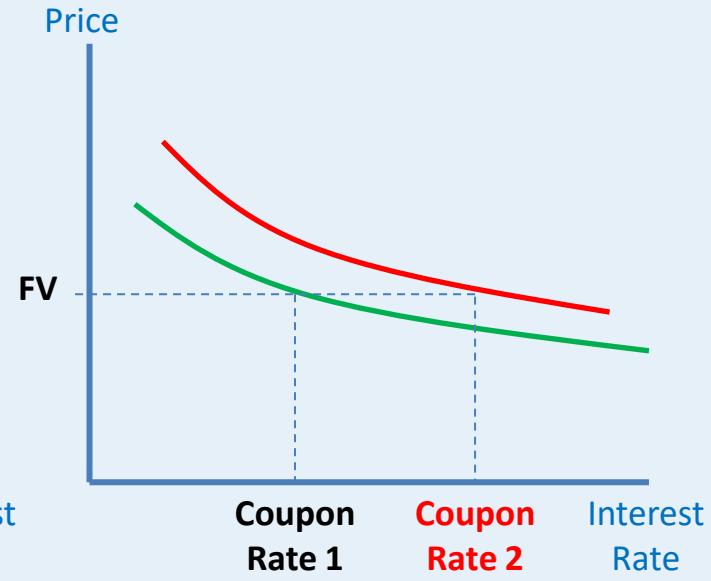
- FV1 = FV2 = 1000
- C1 = C2 = 10%
- M1 = 1 < M2 = 10

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 **coupons** 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

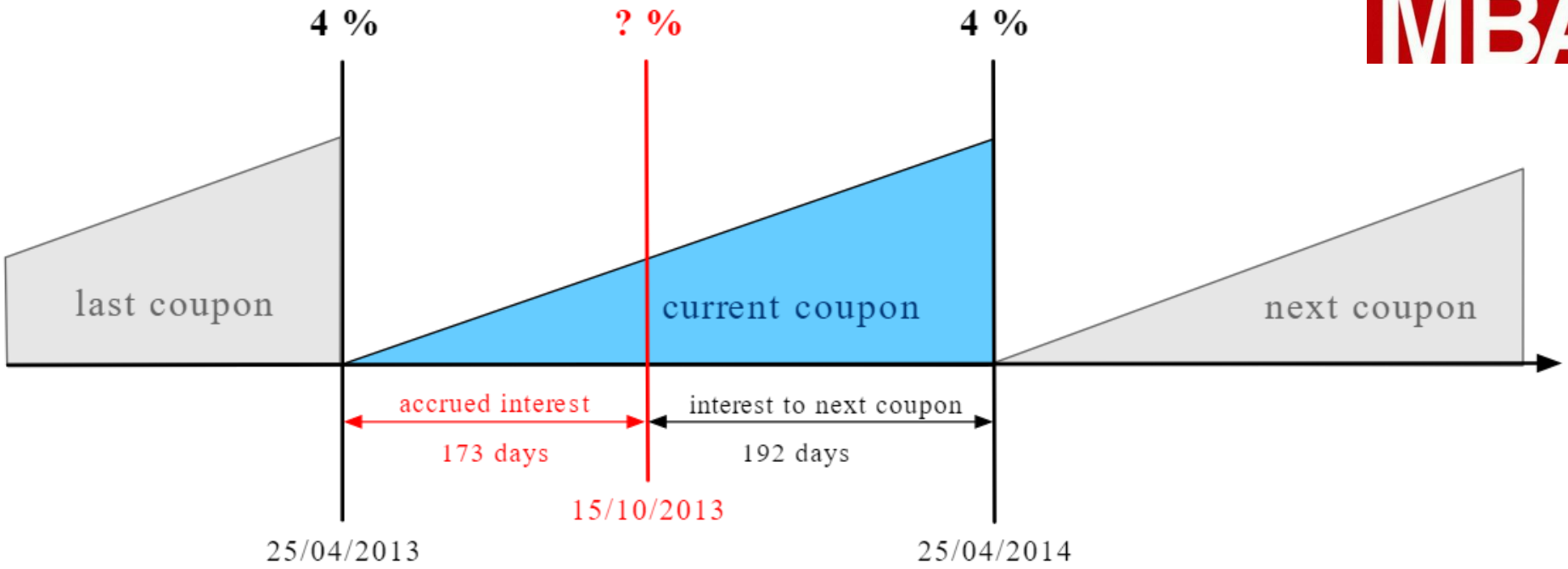
Clean vs. Dirty Prices

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

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

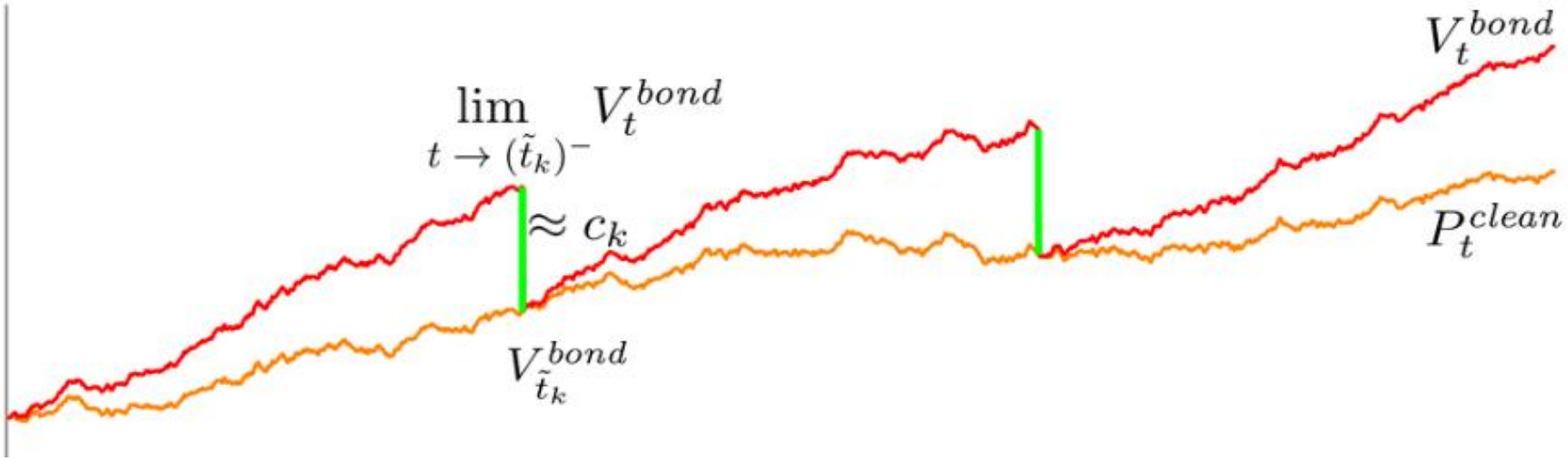
  - FV: Face value
  - C: Coupon rate
  - P: Number of coupon payments made in a year
  - D: Number of days since the last coupon payment
  - T: Number of days between coupon payments

Clean vs. Dirty Prices



Clean vs. Dirty Prices

Actual bond price



Clean vs. Dirty Prices

When Settlement Date is not in the Last Coupon Period

$$\text{Clean Price} = \frac{1}{(1+\frac{Y}{f})^{DF}} \times \{\frac{c}{f} + \frac{c}{Y}\left[1 - \frac{1}{\left(1+\frac{Y}{f}\right)^{n}}\right] + (\text{Par} + \frac{c}{f} \times LCF) \times \frac{1}{\left(1+\frac{Y}{f}\right)^{n+LDF}}\} - \frac{c}{f} \times AIF$$

Y: yield to maturity

f: frequency of coupon. 2 for semiannual

c: coupon

Par: redemption

LCF: last coupon factor is used to calculate the cpn on maturity date

LDF: used to discount cash flow at the maturity to last coupon date

n: number of coupon remaining – 2

AIF: accrued interest factor

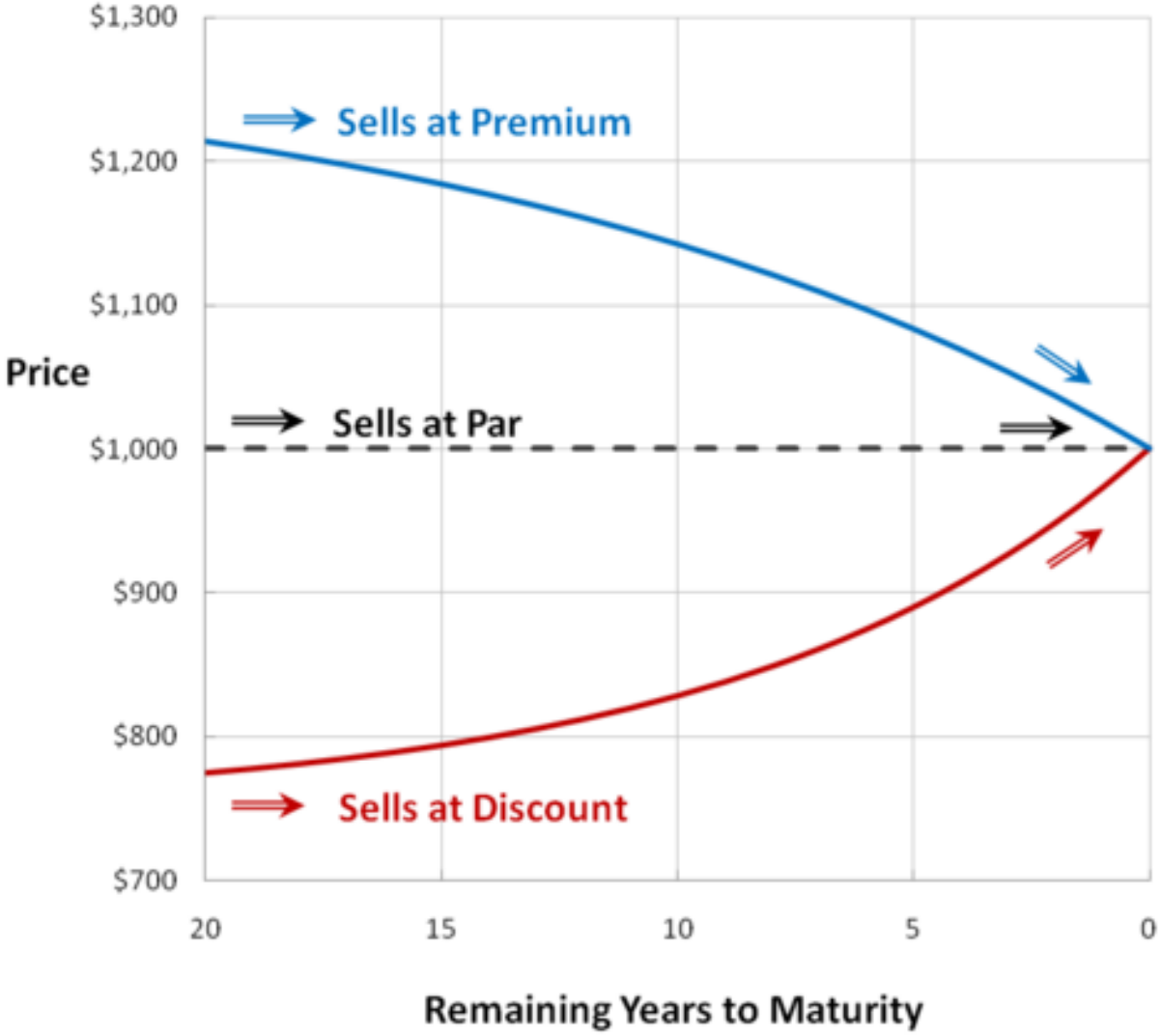
Clean vs. Dirty Prices

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

- 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

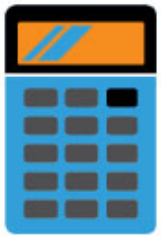
- Let's say we have 5% quarterly returns. Since there are four quarters in a year, the annual returns will be:
- Annual returns = (1+0.05)^4 – 1 = 21.55%

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

$$R_p = \sum_{i=1}^{n} w_i r_i$$

Standard Deviation of a Portfolio – 2 assets

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

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

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