DATASCI 385 Quantitative Finance

Lecture 2: Asset classes and financial instruments

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Suggested reading: Investments Ch 2

Financial markets

- **Financial markets** are segmented into money markets and capital markets
- **Money market**: short-term, marketable, liquid, low-risk debt securities
  - Money market instruments are also called cash equivalents
- **Capital market**: longer term, riskier securities
  - Longer term bond markets
  - Equity markets
  - Derivative markets for options and futures

The money market

- **Money market**: Very short-term, highly marketable debt securities

- Many securities trade in large denominations, not accessible to individual investors

- Money market funds are accessible to individual investors
  - Mutual funds that invest in money market instruments
  - Average maturity of less than 3 months

1969 $100,000 Treasury Bill

Treasury bills

- **Treasury bills**
  - The government raises money by selling bills to the public
  - Investors buy the bills at a discount from the stated maturity (or face) value
  - At maturity, the government pays the investor the face value of the bill
  - Investor's earnings: Difference between purchase price and maturity value
  - Most marketable of all money market instruments
  - Issued with initial maturities of 4, 13, 26, or 52 weeks

Example

Security type ⓘ

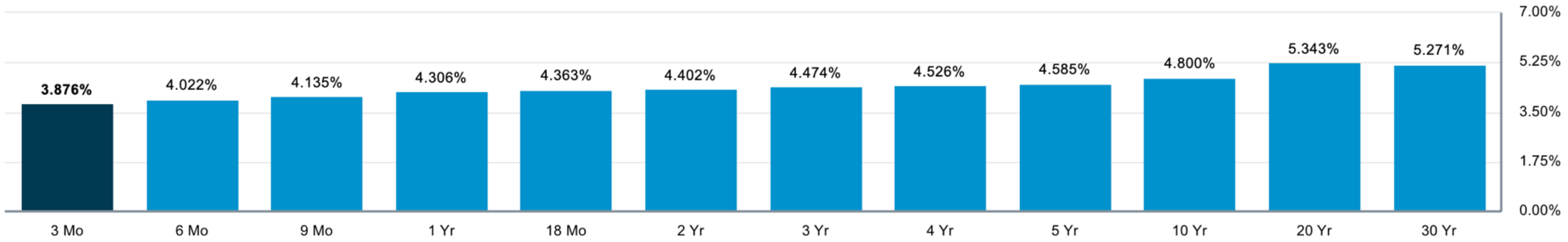
U.S. Treasuries

Term/YTM (%) ⓘ

3 Mo - 3.876%

Maturity range

11/17/2026 - 12/18/2026



3 Month U.S. Treasury Rates

Description	Action	Coupon	Maturity	Quote	Price	Min	Max	YTM %	YTW[1]	Market Depth
912797WF0 US Treasury BILL 12/15/2026	Buy	0.000	12/15/2026	Ask	98.9174	738	8,000	3.878	--	View
912797VA2 US Treasury BILL 12/03/2026	Buy	0.000	12/03/2026	Ask	99.0457	350	100,000	3.865	--	View
912797VH7 US Treasury BILL 12/17/2026	Buy	0.000	12/17/2026	Ask	98.901	100	33,102	3.863	--	View
912797WE3 US Treasury BILL 12/08/2026	Buy	0.000	12/08/2026	Ask	98.995	100	34,655	3.860	--	View
912797VG9 US Treasury BILL 12/10/2026	Buy	0.000	12/10/2026	Ask	98.9782	350	100,000	3.845	--	View
912797SU2 US Treasury BILL 11/27/2026	Buy	0.000	11/27/2026	Ask	99.1158	1,075	15,000	3.831	--	View

6 Month U.S. Treasury Rates

Description	Action	Coupon	Maturity	Quote	Price	Min	Max	YTM %	YTW[1]	Market Depth
912797WD5 **New Issue** US Treasury BILL 03/04/2027	Buy	0.000	03/04/2027	Ask	98.0332	1,000	20,000	4.023	--	View
912797WC7 US Treasury BILL 02/25/2027	Buy	0.000	02/25/2027	Ask	98.1221	746	10,000	3.992	--	View

Ask and bid price

- **Ask price**: Price that a dealer is willing to sell a bill
- **Bid price**: Price that a dealer is willing to buy a bill
- **Bid–ask spread**: The difference in these prices, which is the dealer's source of profit
- Bid yield is higher than asked yield

Bid yield   Asked yield

TREASURY BILLS

MATURITY	DAYS TO MATUR	BID	ASKED	CHANGE	ASKED YIELD
15-Jan-2019	12	2.270	2.260	–0.018	2.293
19-Feb-2019	47	2.368	2.358	0.020	2.398
9-May-2019	126	2.388	2.378	–0.012	2.431
18-Jul-2019	196	2.370	2.360	–0.043	2.424
5-Dec-2019	336	2.415	2.405	–0.105	2.494

US Treasury BILL 03/04/2027

Page last updated: 12:15 PM ET, 09/02/2026 Refresh

The Market Depth table below displays real-time market bids and asks for this security. You must hold the position in this account in order to sell or initiate a bid request.

To begin a trade, click the appropriate Sell or Buy link in the Action column. If there are insufficient market bids available on a sell order, including partial quotes less than your quantity, you can request a bid quote for your security.

If you have requested a Bid on your security, please check the Bid Request Status page for the best bid that has been obtained as, in some limited instances, prices may differ from those shown in the Market Depth or Find Bonds & Fixed Income search pages.

Request a bid   Quantity: 25 ,000 Refresh

Bid (13)					Ask (22)				
Action	Min	Max	Price	YTM	Action	Min	Max	Price	YTM
Sell	1000	20000	98.031	4.028	Buy	1000	20000	98.033	4.023
Sell	500	10000	98.030	4.031	Buy	1	15001	98.034	4.022
Sell	2725	15000	98.029	4.032	Buy	250	10000	98.034	4.022
Sell	925	15000	98.029	4.032	Buy	500	10000	98.035	4.021

EMORY

Bill yield and price

- The first yields in the table are reported using *bank-discount method*
  - Bill's discount from its face value is "annualized" based on a 360-day year
- A T-bill of $10,000 denomination
- Bid yield of 2.388%
- Bill discount from face value:

$$.02388 \times \frac{126}{360} = .8358\%$$

- Bid price:

$$\$10{,}000 \times (1 - .8358\%) = \$9{,}916.42$$

TREASURY BILLS

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An exercise

- What is the ask price for the T-bills maturing on May 9, 2019 with face value $10,000?

TREASURY BILLS

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Treasury bills

- Two issues of *bank-discount method*
  - Assumes that a year has only 360 days
  - Computes the yield as a fraction of par value, but not the price the investor paid
- For a T-bill of $10,000 denomination with asked price $9,916.77
- Treasury-bill's *bond-equivalent ask yield*:

$$(\$10{,}000/\$9{,}916.77 - 1) \times 365/126 = 2.431\%$$

TREASURY BILLS

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15-Jan-2019	12	2.270	2.260	−0.018	2.293
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Treasury-bill's bond-equivalent yield

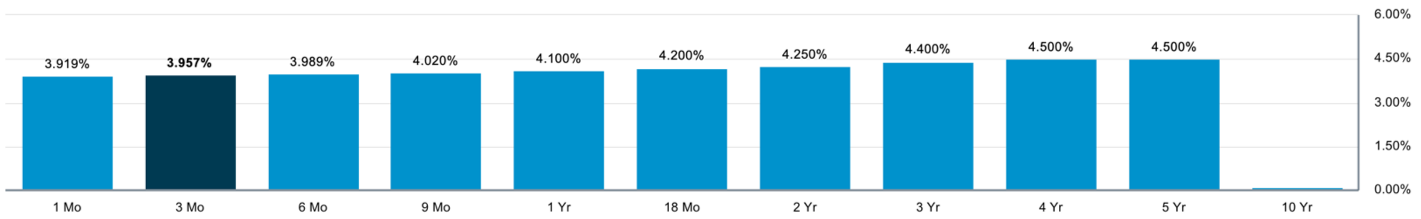
Figure 2.1 Treasury bill yields

Source: The *Wall Street Journal Online*, January 3, 2019.

Certificate of deposit

- A **certificate of deposit,** or CD, is a time deposit with a bank. Time deposits may not be withdrawn on demand
- CDs are treated as bank deposits by the Federal Deposit Insurance Corporation
- They are insured for up to $250,000 in the event of a bank insolvency

Call Type: Non-Callable | Term/APY (%): 3 Mo - 3.957% | Maturity range 11/17/2026 - 12/18/2026 | Bond Market Update



3 Month CD Rates

Description	Action	Coupon	Coupon Frequency	Maturity	Callable	CD Type	APY/YTM %	YTW[1]	Quote	Price	Min	Max	Settlement Date
666613TJ3 **New Issue** Northpointe Bank MI 3.9% CD 12/08/2026	Buy	3.900	At Maturity	12/08/2026	No	Fixed	3.957	--	Ask	100.000	1	34,224	09/08/2026
33744ACF4 **New Issue** First US Bank AL 3.85% CD 12/18/2026	Buy	3.850	At Maturity	12/18/2026	No	Fixed	3.906	--	Ask	100.000	1	1,677	09/18/2026
320165MV2 **New Issue** First Farmers Bank & IN 3.85% CD 12/15/2026	Buy	3.850	At Maturity	12/15/2026	No	Fixed	3.906	--	Ask	100.000	1	5,016	09/15/2026
066519F46 **New Issue** BankUnited, Ntnl Ass FL 3.85% CD 12/11/2026	Buy	3.850	At Maturity	12/11/2026	No	Fixed	3.906	--	Ask	100.000	1	34,248	09/11/2026
02007QFN6 **New Issue** Ally Bank PA 3.85% CD 12/10/2026	Buy	3.850	At Maturity	12/10/2026	No	Fixed	3.906	--	Ask	100.000	1	15,793	09/10/2026
83407DDN3 **New Issue** SoFi Bank, Ntnl Asso UT 3.85% CD 12/09/2026	Buy	3.850	At Maturity	12/09/2026	No	Fixed	3.906	--	Ask	100.000	1	5,116	09/09/2026
15140RGN3 **New Issue** Centier Bank IN 3.85% CD 12/08/2026	Buy	3.850	At Maturity	12/08/2026	No	Fixed	3.906	--	Ask	100.000	1	21,177	09/08/2026

Commercial paper

- **Commercial paper**: Large, well-known companies issue their own short-term unsecured debt notes
- Commercial paper is often backed by a bank line of credit, which gives the borrower access to cash that can be used to pay off the paper at maturity
- Maturities range up to 270 days, most often less than 1 or 2 months, usually in multiples of $100,000

Money market funds

- **Money market funds**: mutual funds invest in money market instruments
  - Government money market fund: invest in Treasury securities
  - Prime money market fund: invest in floating-rate commercial paper
  - Municipal money market fund: invests in municipal bonds (free from federal and state tax)

Government and U.S. Treasury Money Market[3]

Fidelity® Government Money Market Fund (SPAXX)
Fidelity® Government Money Market Fund - Premium Class (FZCXX)
Fidelity® Government Cash Reserves (FDRXX)
Fidelity® Investments Money Market Government Portfolio - Class I (FIGXX)
Fidelity® Investments Money Market Government Portfolio - Institutional Class (FRGXX)
Fidelity® Investments Money Market Treasury Only- Class I (FSIXX)
Fidelity® Investments Money Market Treasury Only- Institutional Class (FRSXX)
Fidelity® Investments Money Market Treasury- Class I (FISXX)
Fidelity® Investments Money Market Treasury- Institutional Class (FRBXX)
Fidelity® Treasury Money Market Fund (FZFXX)
Fidelity® Treasury Only Money Market Fund (FDLXX)

State Municipal Money Market[4]

Retail Municipal

Fidelity® California Municipal Money Market Fund (FABXX)
Fidelity® California Municipal Money Market Fund - Premium Class (FSPXX)
Fidelity® California Municipal Money Market Fund - Institutional Class (FSBXX)
Fidelity® Massachusetts Municipal Money Market Fund (FAUXX)
Fidelity® Massachusetts Municipal Money Market Fund - Premium Class (FMSXX)
Fidelity® Massachusetts Municipal Money Market Fund - Institutional Class (FMAXX)
Fidelity® New Jersey Municipal Money Market Fund (FAYXX)
Fidelity® New Jersey Municipal Money Market Fund - Premium Class (FSJXX)
Fidelity® New Jersey Municipal Money Market Fund - Institutional Class (FSKXX)
Fidelity® New York Municipal Money Market Fund (FAWXX)

National Municipal Money Market[4]

Retail Municipal

Fidelity® Investments Money Market Tax Exempt - Class I (FTCXX)
Fidelity® Municipal Money Market Fund (FTEXX)
Fidelity® Tax-Exempt Money Market (FMOXX)
Fidelity® Tax-Exempt Money Market Fund - Premium Class (FZEXX)

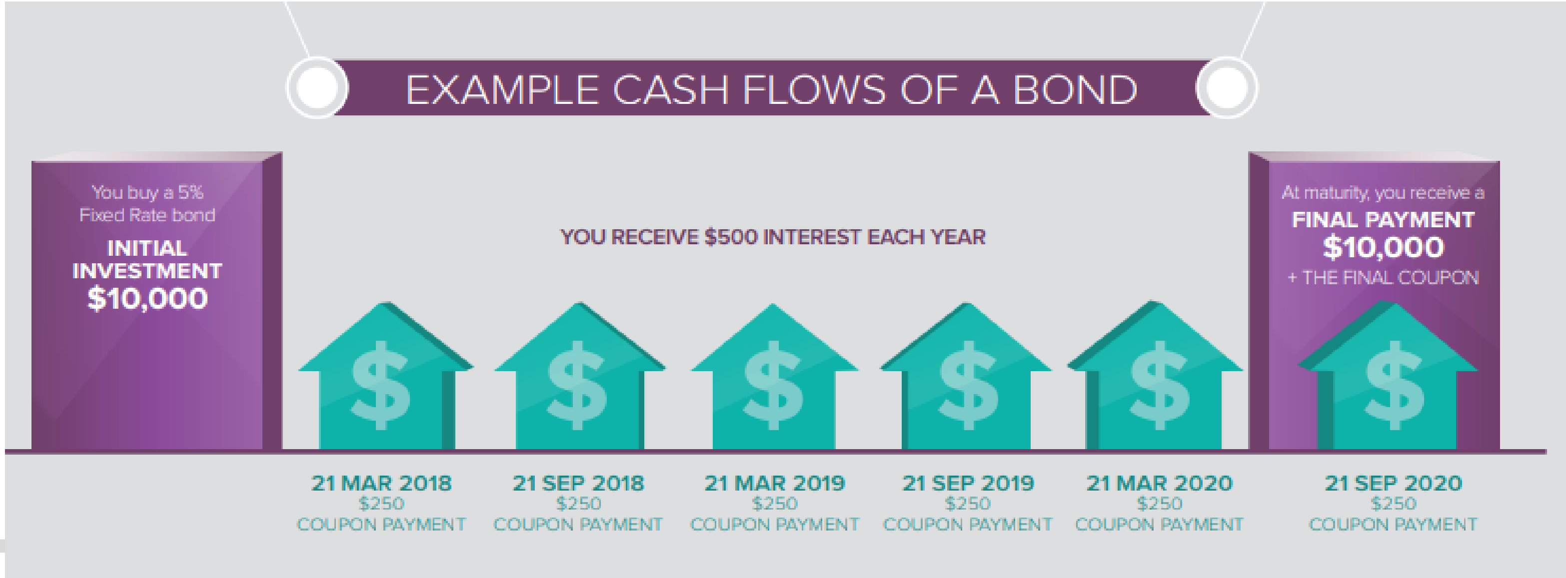
Prime Money Market

Retail Prime[4]

Fidelity® Investments Money Market - Money Market Portfolio - Class I (FMPXX)
Fidelity® Investments Money Market - Money Market Portfolio - Institutional Class (FNSXX)
Fidelity® Money Market Fund (SPRXX)
Fidelity® Money Market Fund - Premium Class (FZDXX)

The bond market

- **Bond market**: Longer term borrowing or debt instruments than those trade in the money market
- Also known as *fixed-income capital market*: Most of them promise either a fixed stream of income or a stream of income determined by a specific formula
  - *Coupon payments*: Interest payments before maturity, commonly made semiannually



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The bond market: Treasury notes and bonds

- **Treasury notes** and **Treasury bonds**: issued by the U.S. government
- **Treasury notes**: maturities ranging up to 10 years
- **Treasury bonds**: maturities ranging from 10 to 30 years
- Most commonly traded in denominations of **$1,000**

Price and yield of Treasury notes and bonds

- Prices are quoted as a percentage of par
- For the $1,000 par value bond maturing on August 15, 2029
- Bid price: $132.7266\% \times \$1{,}000 = \$1{,}327.266$
- Asked price: $132.7891\% \times \$1{,}000 = \$1{,}327.891$
- Semiannual payments: $\frac{6.125\%}{2} \times \$1{,}000 = \$30.625$

Bid price

Asked price

LISTING OF TREASURY ISSUES

MATURITY	COUPON	BID	ASKED	CHANGE	ASKED YIELD TO MATURITY
15-Feb-2019	2.750	100.0391	100.0547	0.0078	2.256
30-Apr-2021	2.250	99.7500	99.7656	0.2344	2.354
15-May-2023	1.750	97.4531	97.4688	0.4766	2.364
15-Aug-2029	6.125	132.7266	132.7891	1.1406	2.575
15-Feb-2036	4.500	125.4688	125.5313	1.5391	2.637
15-Aug-2048	3.000	101.8984	101.9297	1.5391	2.902

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Municipal bonds

- **Municipal bonds**: issued by state and local governments
  - Their interest income is exempt from federal income taxation
  - Also exempt from state and local taxation in the issuing state
- Choose between taxable and tax-exempt (municipal) bonds: Compare after-tax returns on each bond

Equivalent taxable yield of tax-exempt bond

$$r_{taxable}(1-t) = r_{muni} \quad \text{or} \quad r_{taxable} = r_{muni}/(1-t)$$

where t is combined federal plus local marginal tax bracket

1 Year Municipal (AAA) Rates

Description	Action	State	S&P Rating	Moody's Rating	Coupon	Maturity	Callable	Taxable	Quote	Price	Min	Max	YTM %
915506NU9 UPPER ARLINGTON OHIO GO 5% 12/01/2027	Buy	OH	AAA	NR	5.000	12/01/2027	No	No	Ask	102.890	5	10	2.621
229255JL9 CRYSTAL LAKE ILL GO 4% 12/15/2027	Buy	IL	AAA	NR	4.000	12/15/2027	No	No	Ask	101.738	5	20	2.612
39167JDL6 GREATER CLEVELAND RE REV 5% 12/01/2027	Buy	OH	AAA	Aa1	5.000	12/01/2027	No	No	Ask	102.902	10	10	2.611
18452QAF4 CLEAN WTR SVCS ORE S REV 5% 10/01/2027	Buy	OR	AAA	Aa1	5.000	10/01/2027	No	No	Ask	102.523	15	15	2.609
24916PJF5 DENVER COLO CITY & C REV 5% 12/15/2027	Buy	CO	AAA	Aaa	5.000	12/15/2027	No	No	Ask	102.998	15	15	2.606
262651VA7 DU PAGE CNTY ILL FST GO 5% 11/01/2027	Buy	IL	AAA	NR	5.000	11/01/2027	No	No	Ask	102.719	5	45	2.604

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Tax-exempt of municipal bonds

- Cutoff tax bracket

$$1 - \frac{r_{muni}}{r_{taxable}}$$

- If an investor's tax bracket is higher than the cutoff bracket, municipal bond is more appealing

- Municipal bonds is attractive to high-tax-bracket investors

	Tax-Exempt Yield				
Marginal Tax Rate	1%	2%	3%	4%	5%
20%	1.25%	2.50%	3.75%	5.00%	6.25%
30	1.43	2.86	4.29	5.71	7.14
40	1.67	3.33	5.00	6.67	8.33
50	2.00	4.00	6.00	8.00	10.00

Table 2.1

Equivalent taxable yields corresponding to various tax-exempt yields

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Exercise

- Suppose your combined federal plus state tax bracket is 30%.

- Would you prefer to earn a 6% taxable return or a 4% tax-free return?

- What is the equivalent taxable yield of the 4% tax-free yield?

Corporate bonds

- **Corporate bonds**: Private firms borrow money from the public
  - Semiannual coupons over their lives and return the face value at maturity
  - Riskier than Treasury bonds
- **Secured bonds**: Secured by a specific asset owned by the issuer
- **Unsecured bonds**, called *debentures:* Backed by general credit rather than by specified assets

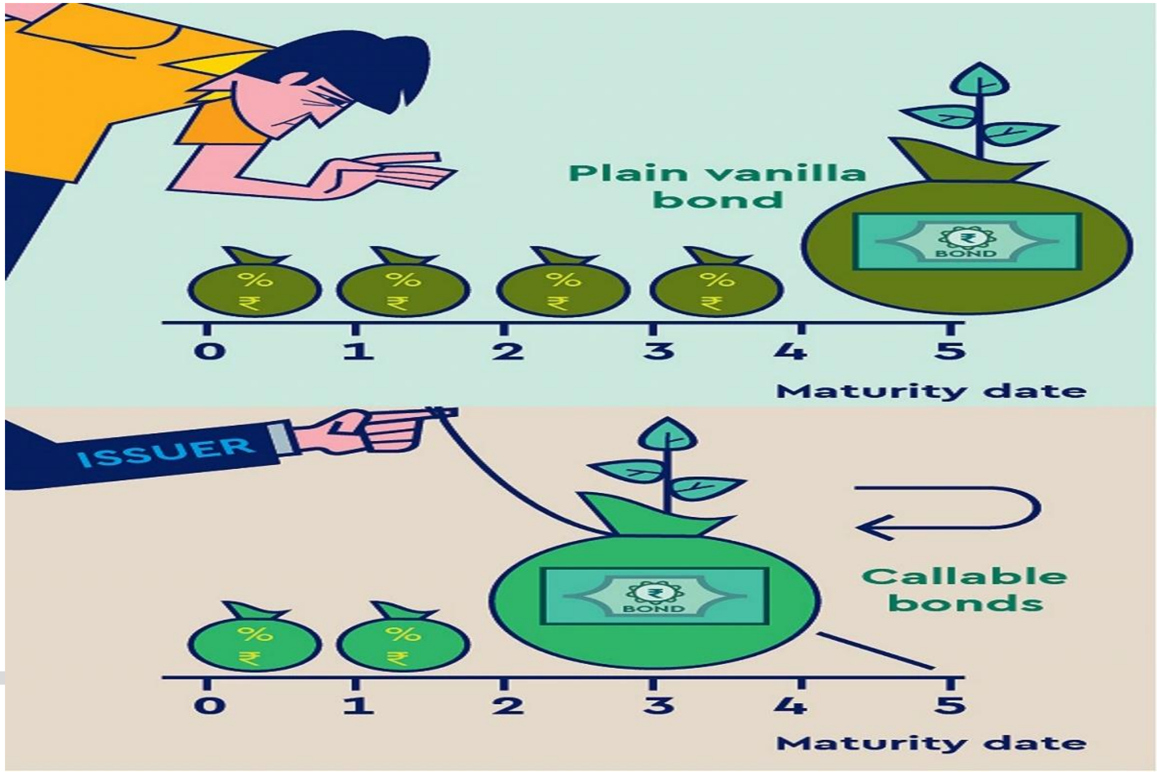
1 Year Corporate (AA) Rates

Description	Action	S&P Rating	Moody's Rating	Coupon	Maturity	Callable	Quote	Price	Min	Max	YTM %
801060AE4 Sanofi 3.75% 11/03/2027 Make Whole Call	Buy	AA	Aa3	3.750	11/03/2027	Yes	Ask	99.429	2	50	4.253
023135CP9 Amazon.com, Inc. 4.55% 12/01/2027 Callable Make Whole Call	Buy	AA	A1	4.550	12/01/2027	Yes	Ask	100.398	2	500	4.213
037833DK3 Apple Inc. 3% 11/13/2027 Callable Make Whole Call Continuously-Callable on 08/13/2027 @ 100.00000	Buy	AA+	Aaa	3.000	11/13/2027	Yes	Ask	98.667	5	150	4.152
037833DB3 Apple Inc. 2.9% 09/12/2027 Callable Make Whole Call Continuously-Callable on 06/12/2027 @ 100.00000	Buy	AA+	Aaa	2.900	09/12/2027	Yes	Ask	98.766	15	300	4.141
023135BC9 Amazon.com, Inc. 3.15% 08/22/2027 Callable Make Whole Call	Buy	AA	A1	3.150	08/22/2027	Yes	Ask	99.068	100	500	4.140
931142EX7 Walmart Inc. 3.95% 09/09/2027 Callable Make Whole Call	Buy	AA	Aa2	3.950	09/09/2027	Yes	Ask	99.817	10	250	4.135
02079KAJ6 Alphabet Inc. 0.8% 08/15/2027 Callable Make Whole Call	Buy	AA+	Aa2	0.800	08/15/2027	Yes	Ask	96.980	10	500	4.073

Callable corporate bonds

- **Callable bonds**: The firm has the option to repurchase the bond from the holder at a defined call price before maturity
  - Call price is usually higher than the par value
  - Usually called when interest rate is low as the firm can refinance at a lower rate

- Example: A 5-year maturity 9% coupon bond with par value $1,000 paying coupons semiannually is callable in three years at a call price of $1,050



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