IS4228
Information technology and financial services

Lecture 2

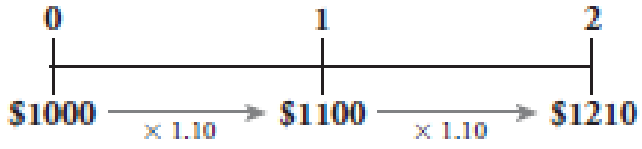
22 August, 2023

The three rules of time travel

- **Financial decisions often require comparing or combining cash flows that occur at different points in time.**
- **Rule 1:** ***it is only possible to compare or combine values at the same point in time.***
- **Rule 2:** ***to move a cash flow forward in time, you must compound it.***
- **Rule 3:** ***to move a cash flow back in time, you must discount it.***

Compounding

- **Assume a 10% interest rate and we have $1000 on date 0**



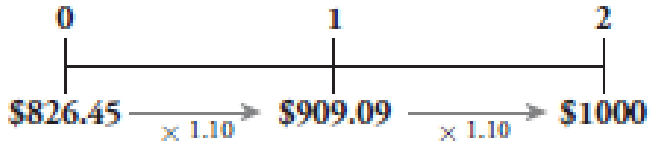
- **$FV_n = C*(1+r)*(1+r)*\ldots*(1+r) = C*(1+r)^n$**

n times

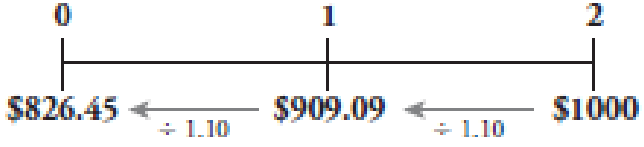
- **Future value at the end of year *n*. (C is the cash flow now, and r is the interest rate)**

Discounting

- **If we receive $1000 at the end of year 2, it is equivalent to**



- **Therefore, this $1000, need to be discounted as $826.45 at date 0**



- **$PV=C/(1+r)^n$**
- **C is the cash flow at the end of year n, r is the interest rate**

Overview

- **The law of one price**
- **Perpetuity and annuity**
- **Interest rate quotes and adjustments**
- **Investment decision rules**
- **The determinants of interest rates**
- **Buy now, Pay Later (BNPL)**

Arbitrage

- **The practice of buying and selling equivalent goods in different markets to take advantage of a price difference is known as arbitrage.**
- **Any situation in which it is possible to make a profit without taking any risk or making any investment as an arbitrage opportunity.**
- **Arbitrage opportunities are like money lying in the street; once spotted, they will quickly disappear. Thus the normal state of affairs in markets should be that no arbitrage opportunities exist. We call a competitive market in which there are no arbitrage opportunities a normal market.**

The Law of One Price

- **If equivalent investment opportunities trade simultaneously in different competitive markets, then they must trade for the same price in all markets.**

- **Transaction costs?**

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Perpetuities

- **A perpetuity is a stream of equal cash flows that occur at regular intervals and last forever.**
  - E.g., the British government bond called a consol

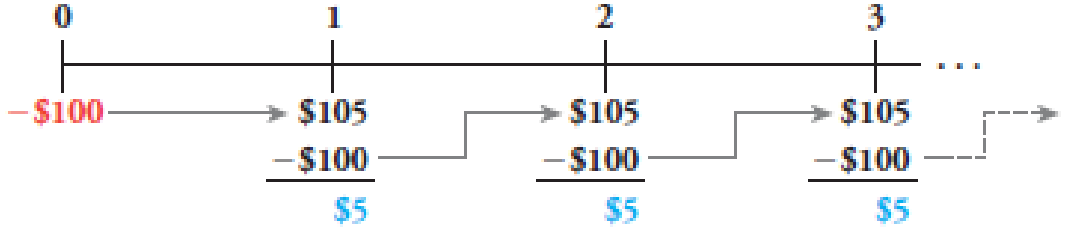
- **The present value of the perpetuity above is**

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

- **This sum can be calculated mathematically directly, or…**

Perpetuities

- **Using the Law of One Price!**
- **Suppose you could invest $100 in a bank account paying 5% interest per year forever, and you withdraw the $5 interest at the end of each year**



- **You generated a $5 perpetuity, and the cost is $100.**
- **The present value for this $5 perpetuity is $100.**
- **You can generate a perpetuity of C, with the cost of C/r.**

$$PV(C \text{ in perpetuity}) = \frac{C}{r}$$

Perpetuities

- $\sum_{n=1}^{\infty} \frac{C}{(1+r)^n} = C\left(\frac{\frac{1}{1+r}}{1-\frac{1}{1+r}}\right) = C(\frac{1}{r})$

Annuities

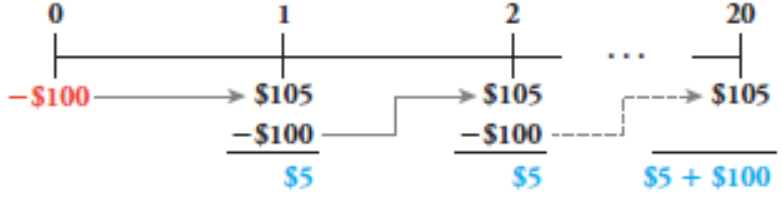
- **An annuity is a stream of N equal cash flows paid at regular intervals.**
- **The difference between an annuity and a perpetuity is that an annuity ends after some fixed number of payments.**
- **Most car loans, mortgages, and some bonds are annuities.**

- **The present value of the annuity above is**

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

Annuities

- **Again, you can calculate the sum mathematically directly, or with the Law of One Price.**
- **Consider the $100 with 5% interest rate example again, but now you withdraw it from the bank 20 years later.**



- **You generate a $5 annuity for 20 years and a $100 cash flow at the end of 20 years, with $100 now.**

$$\$100 = PV(\text{20-year annuity of } \$5 \text{ per year}) + PV(\$100 \text{ in 20 years})$$

Annuities

- **The PV for the $5 annuity for 20 years is**

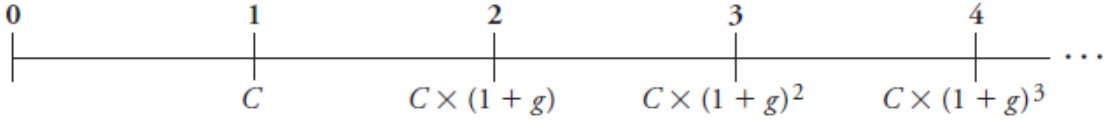
$$PV(\text{20-year annuity of \$5 per year}) = \$100 - PV(\$100 \text{ in 20 years})$$
$$= 100 - \frac{100}{(1.05)^{20}} = \$62.31$$

- **Generally, the PV for an annuity is**

$$PV(\text{annuity of } C \text{ for } N \text{ periods with interest rate } r) = C \times \frac{1}{r}\left(1 - \frac{1}{(1+r)^N}\right)$$

Growing perpetuity

- **A growing perpetuity is a stream of cash flows that occur at regular intervals and grow at a constant rate forever.**
- **In general, a growing perpetuity with a first payment C and a growth rate g will have the following series of cash flows:**

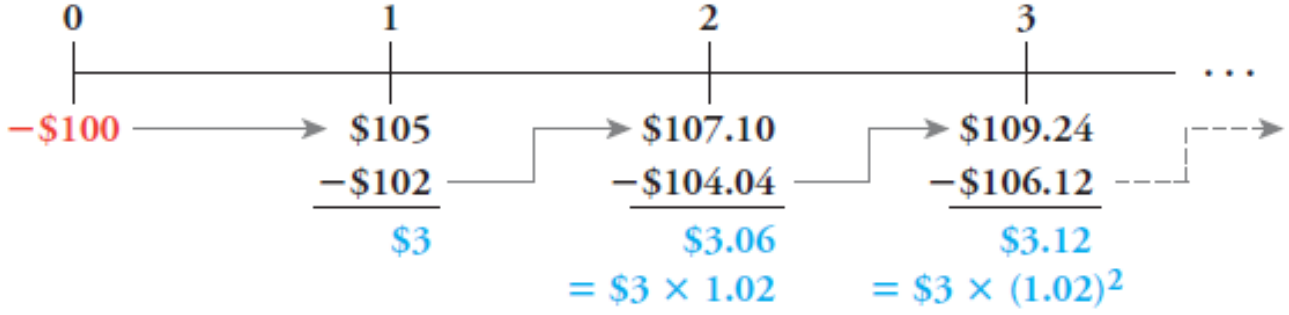


- **The present value is**

$$PV = \frac{C}{(1+r)} + \frac{C(1+g)}{(1+r)^2} + \frac{C(1+g)^2}{(1+r)^3} + \cdots = \sum_{n=1}^{\infty} \frac{C(1+g)^{n-1}}{(1+r)^n}$$

Growing perpetuity

- **If g ≥ r, the sum is infinite**
- **Growing perpetuities of this sort cannot exist in practice because no one would be willing to offer one at any finite price.**
- **We assume that g < r for a growing perpetuity.**
- **Consider the example again, but now you with draw 3/5 of the interest each year while leaving the other 2/5 in the bank account**



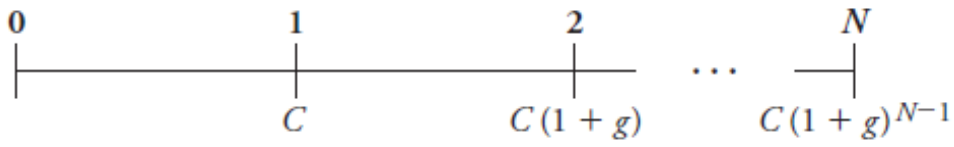
Growing perpetuity

- **You now have a growing perpetuity with initial payment of $3 and grows at 2% each year, and the present value is again $100.**
- **Generally, if you have amount P in the bank account and to have a growing perpetuity with growth rate g, the amount that can be withdrawn each year is C=(r-g)P**
- **Therefore,**

$$PV(\text{growing perpetuity}) = \frac{C}{r-g}$$

Growing annuity

- **A growing annuity is a stream of N growing cash flows, paid at regular intervals.**



- **The present value of a growing annuity is**

$$PV = C \times \frac{1}{r-g}\left(1 - \left(\frac{1+g}{1+r}\right)^{N}\right)$$

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Interest Rate Quotes and Adjustments

- **Interest payments can occur at different intervals**
  - Annually, semiannually, monthly, semimonthly, daily, …
  - Some business models depend on short interest payment intervals
- **Interest rates are quoted in a variety of ways.**
- **Discount rate over a period, which could be a year, half a year, etc., should reflect the actual return we could earn over that time period.**

The Effective Annual Rate

- **EAR: The Effective Annual Rate**
  - Also referred to as the effective annual yield (EAY) or the annual percentage yield (APY)
- **The actual amount of interest that will be earned at the end of one year**
- **Compounding is taken into account**
- **For example, if an interest is paid semiannually and the EAR is 10%**
  - Every half a year, the interest payment is $(1+10\%)^{0.5}-1=4.88\%$

The Effective Annual Rate

- **When the EAR is r, how to discount cash flows?**

- **Discounted by $1/(1+r)^n$**
  - n is the number of years from now
  - n can be integer or not
  - n can be larger than 1 or not

Annual Percentage Rates

- **APR: Annual Percentage Rates**
- **The amount of simple interest earned in one year**
- **Compounding is not taken into account**
- **APR quote is typically less than the actual amount of interest that you will earn.**
- **To compute the actual amount earned, and to discount cash flows properly, APR needs to be converted to EAR.**

Annual Percentage Rates

- **For example, "6% APR with monthly compounding"**
  - 6%/12 = 0.5% interest every month
  - EAR = $(1+0.5\%)^{12}$ -1 = 6.17%
- **$1+EAR=(1+APR/k)^k$**
  - k is the compounding periods per year
  - E.g., k = 12 if compounded monthly

Compounding Interval	Effective Annual Rate
Annual	$(1 + 0.06/1)^1 - 1 = 6\%$
Semiannual	$(1 + 0.06/2)^2 - 1 = 6.09\%$
Monthly	$(1 + 0.06/12)^{12} - 1 = 6.1678\%$
Daily	$(1 + 0.06/365)^{365} - 1 = 6.1831\%$

Application: Discount Rates and Loans

- **Many loans, such as mortgages and car loans, are amortizing loans.**
- **"6.75% APR for 60 months"**
  - The compounding interval is one month.
- **How much payment occurs each month for a loan of $30,000 with the term above?**
  - An annuity over 60 periods whose present value is $30,000
  - The interest rate over each period is 6.75%/12=0.5625%
  - $C*1/0.005625*(1-1/(1+0.005625)^{60})=30000$
  - C=590.50

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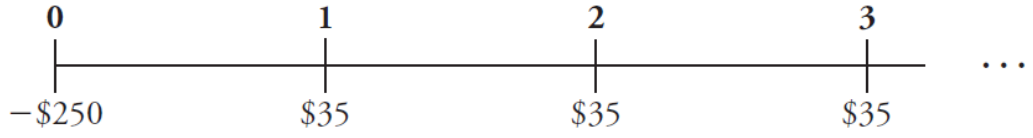
NPV decision rule

- **Consider a stand-alone project, we want to make a take-it-or-leave-it decision.**
  - By undertaking this project, the firm does not constrain its ability to take other projects.

- **NPV rule: compare the NPV of the project and take it if its NPV is positive while leaving it if its NPV is negative**

Applying the NPV rule

- **E.g., a farm decides whether to produce a new fertilizer at a substantial cost savings over the company's existing line of fertilize ($35m per year), which requires a plant that can be built with an immediate cost ($250m).**



- **NPV = -250+35/r**
- **NPV is positive if r<14%, negative if r>14%**

IRR decision rule

- **Internal rate of return (IRR): the interest rate that sets the net present value of the cash flows equal to zero.**
- **E.g., the IRR of the project just mentioned is 14%**
- **IRR rule: Take a project if its IRR exceeds the interest rate , leave it if its IRR is less than the interest rate**

- ***IRR rule is only guaranteed to work for a stand-alone project if all of the project's negative cash flows precede its positive cash flows***

IRR decision rule

- **Think about an example whose cash flow is exactly the reverse of the previous example**
- **Say, you are a celebrity, and a publisher wants to buy your future diaries with an immediate payment of $250k, and your opportunity cost of writing the diaries is $35k per year.**
- **NPV = 250-35/r**
- **IRR = 14%**
- **NPV rule: Accept the offer if interest rate>14% and reject it if interest rate<14%**
- **Opposite to the IRR rule**

Sensitivity analysis

- **Sensitivity analysis breaks the NPV calculation into its component assumptions and shows how the NPV varies as the underlying assumptions change.**
  - What if…
- **E.g., IRR can be interpreted as a sensitivity analysis**
  - What if the interest rate is …
- **Sensitivity analysis in cost, sales, …**

Choosing between projects

- **When projects are mutually exclusive, choose the one with highest NPV.**
- **Does IRR work?**
- **Consider the following two projects**
  - Immediate investment of $1m, with IRR of 5%
  - Immediate investment of $1, with IRR of 1000%
- **Differences in scale for IRR**

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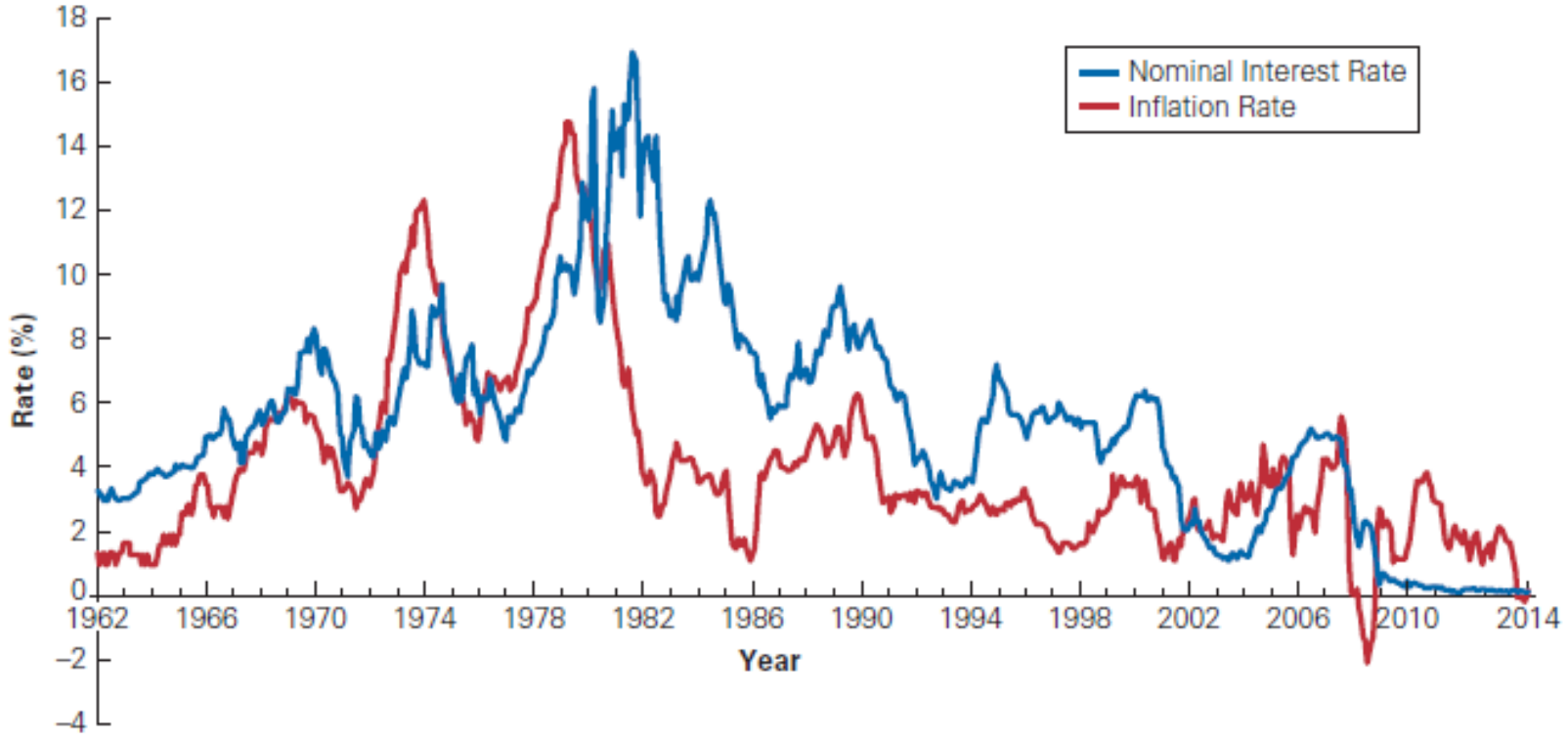
Inflation and Real Versus Nominal Rates

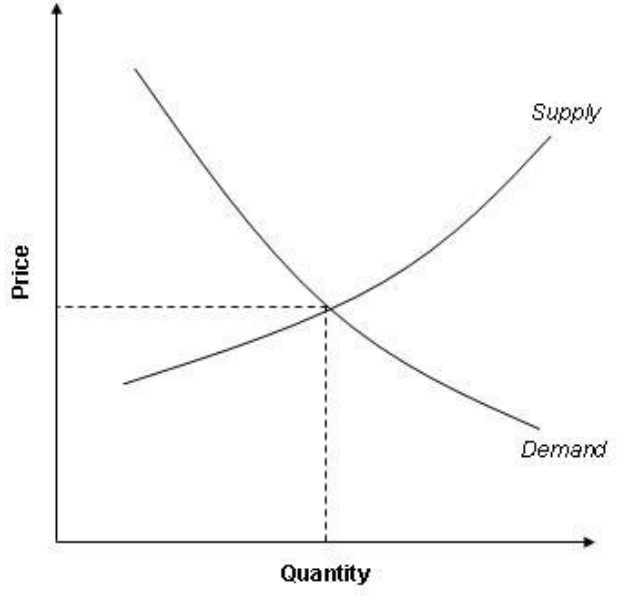
- **The interest rates that are quoted are nominal interest rates (r)**
  - the rate at which the money will grow
- **Prices of items could also grow, known as inflation (i)**
- **Real interest rate (r_r), characterize the rate of growth of purchasing power**
- **Growth of purchasing power = Growth of money/Growth of prices**
- **$1+r_r=(1+r)/(1+i)$**
- **r_r is approximately r-i**

U.S inflation rate and nominal interest rate



The determinants of interest rates

- **Interest rate**
  - the price of capital
- **Mainly determined by the supply and demand of capital**
- **Supply comes from savings**
- **Demand comes from investments**



The Yield Curve

- **Interest rates for loans or investments of different terms are usually different.**
- **The yield curve is a graph that characterizes the relationship between interest rates and terms.**
- **Practically, cash flows are discounted with these different interest rates**

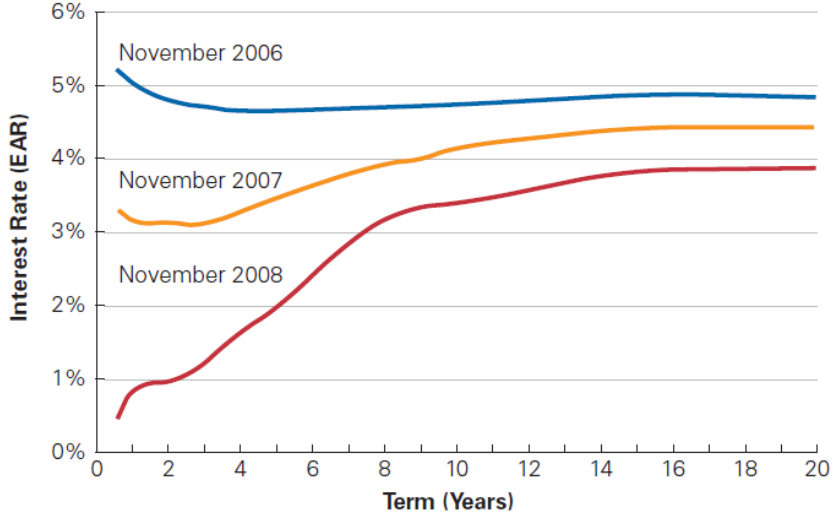
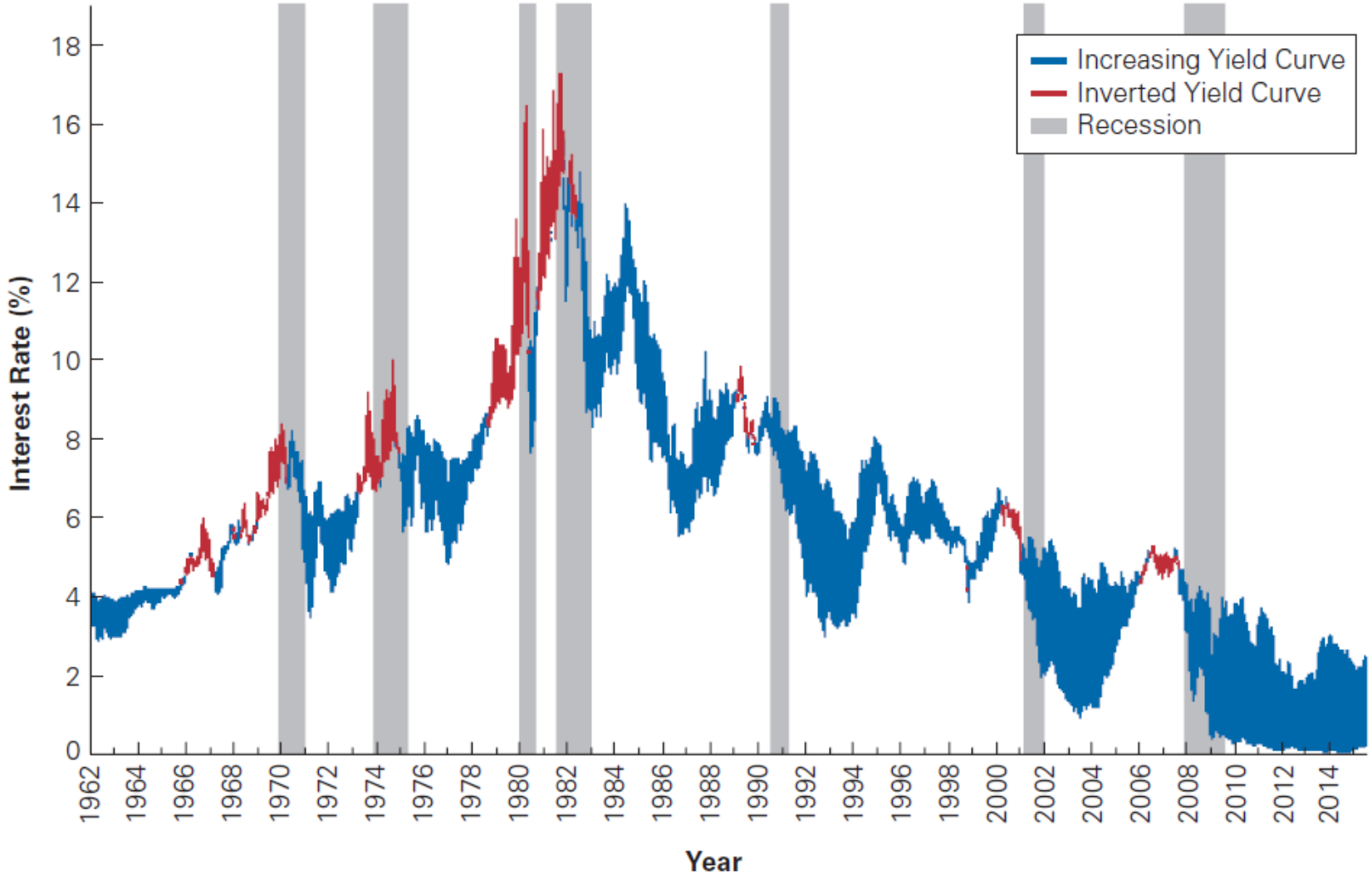


Figure: The yield curves for U.S Treasury

U.S. Interest Rates and Recessions



Interest Rate Expectations

- **Investors expect interest rate to rise in the future**

→ **short term investments (bank deposits) and then reinvest**

→ **high supply for short term capital**

- **Investors expect interest rate to fall in the future**

→ **long term investments (bank deposits)**

→ **high supply for long term capital**

- **If interest rates are expected to rise**

→ **short term rates tend to be lower than long term rates**

- **If interest rates are expected to fall**

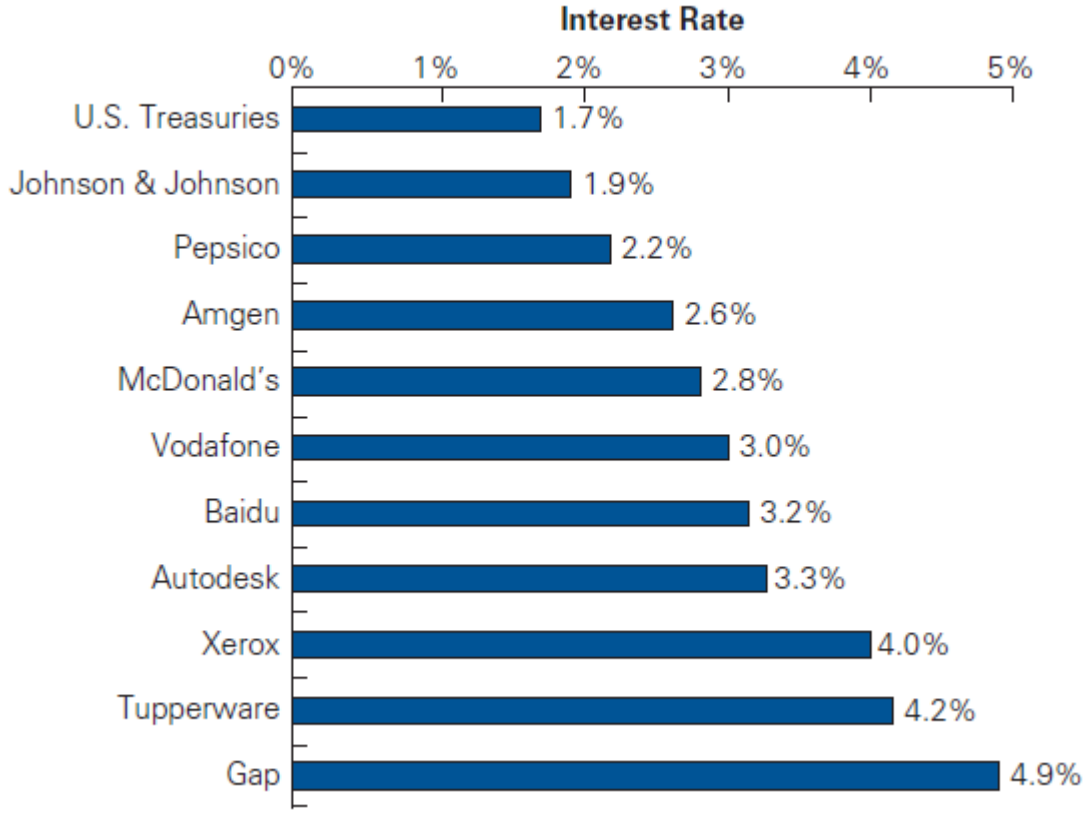
→ **short term rates tend to be higher than long term rates**

The yield curve and the economy

- **Investors value liquidity → the long term interest rates are naturally higher than short term ones**
- **If the short term ones are higher → a strong expectation that the interest rates will fall**
- **When the interest rates are higher?**
  - Think about the demand of capital
  - When the economy is booming
- **A strong expectation that the interest rates will fall reflects a strong expectation that the economy is going into a recession**

Risk and Interest Rates

- **Interest rate differs across borrowers because of the risk of default**



Subprime mortgage crisis

- **Some loans, such as adjustable rate mortgages (ARMs), have interest rates that are not constant over the life of the loan.**
- **ARMs were the most common type of so-called “subprime” loans made to homebuyers with poor credit histories.**
- **These loans often featured low initial rates, aptly named teaser rates.**
- **Prior to 2007, while interest rates remained low and home prices were high (and increasing), such borrowers were able to avoid default simply by refinancing their loans into new loans that also featured low initial teaser rates.**
- **But as mortgage rates increased and housing prices began to decline in 2007, this strategy for keeping their loan payments low was no longer possible.**

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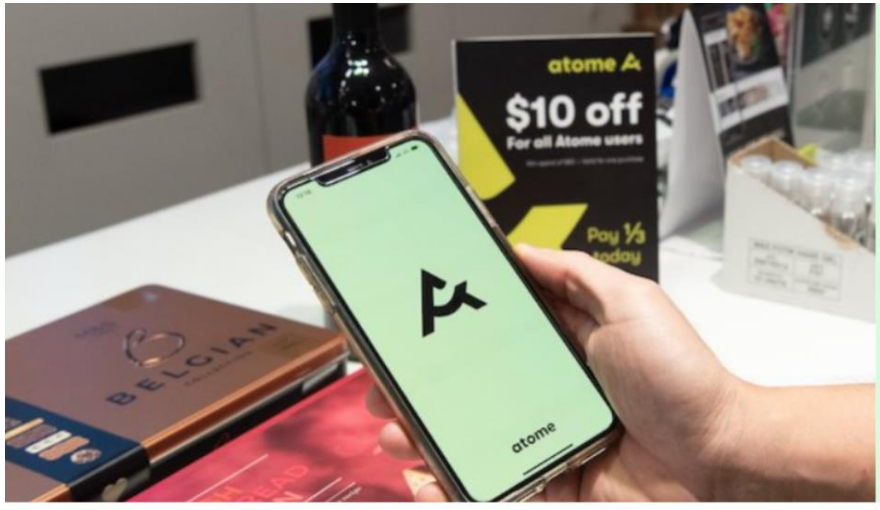
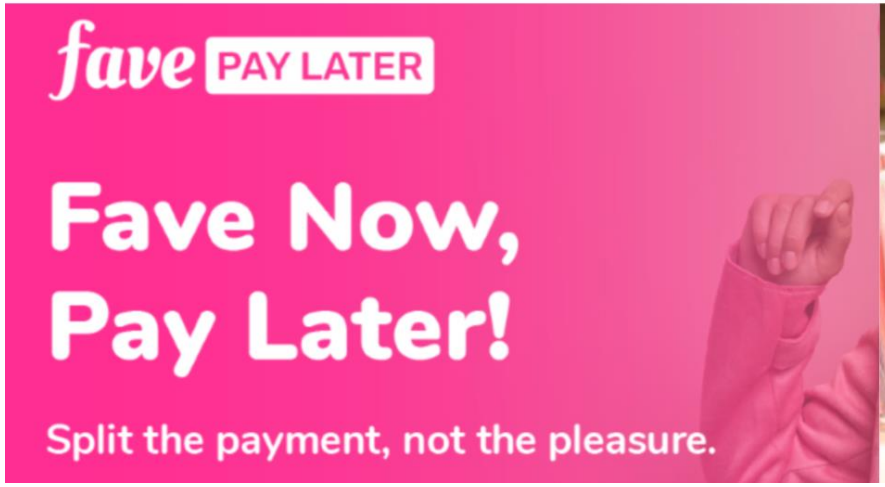
Buy now Pay later (BNPL)





Buy now Pay later (BNPL)

- **A fintech-enabled payment option**
- **Unsecured consumer credit**
  - usually no or little credit check
- **Most commonly offered on e-commerce platforms**

- **BNPL divides a consumer's purchase into multiple equal payments, with the first due at checkout.**

- **Shorter-term BNPL products are usually interest free, while longer-term BNPL products may charge interest.**

Two types of BNPL

- **One type of BNPL product is offered directly to consumers by fintechs before a purchase is made**
  - Target young and financially underserved consumers such as those with no credit or bad credit
  - The credit limits associated with these services tend to be lower, ranging from hundreds of dollars up to thousands
  - credit limits may increase as a consumer demonstrates creditworthiness
  - BNPL services include a virtual or physical payment card to make purchases, which typically can only be used at participating merchants.

Two types of BNPL

SHOULD YOU BUY NOW AND PAY LATER?

PROVIDER	INSTALMENT TENURE	LATE PAYMENT FEE	NOTABLE MERCHANTS
Atome	3 monthly payments	From $20	Sephora, Zara
Grab PayLater	Up to 4 monthly payments	$10	Scanteak, HipVan
hoolah	3 monthly payments	$5 - $30	Nike, Aldo
OctiFi	3 monthly payments	From $15	Electro Bike, Disseta Spa
Rely	Up to 3 monthly payments	$1 - $40	Qoo10, JD Sports
Split	3 monthly payments	$0	Dyson, Fashrevo

and more...

SeedlyReads

Two types of BNPL

- **The other is offered during a purchase through a merchant who partners with a fintech or financial institution**
  - Broader target
  - higher credit limits that may reach up to tens of thousands of dollars and repayment terms that range from six weeks to 60 months (depending on the type of merchant).
  - Unlike shorter-term loans, longer-term loans (3 months or more) typically require no upfront payment at the time of purchase. Interest rates vary according to the length and value of the loan and can range from 0 percent to nearly 30 percent.

So, what exactly is BNPL?

- **What defines a financial product?**
- **What is the timeline of cashflows for a BNPL?**
  - T_0: + product/gift card
  - T_1: - first payment
  - …
  - T_N: - last payment
- **If the interest rate is zero, is such a BNPL worth it?**

Revenue for the fintechs

- **Primarily derived from fees charged to the merchants that accept the loans as a customer payment option**
- **May also be generated from late fees or penalties charged to consumers who fail to comply with the terms of repayment**

Consumer Adoption, Benefits, and Risks

Country	BNPL market share across payment methods (%) E-commerce	Total e-commerce spend (USD Bn)	BNPL e-commerce transaction volume (USD Bn)	BNPL market share across payment methods (%) POS	POS spend (USD Bn)	BNPL POS spend volume (USD Bn)
Indonesia	3	25	0.750	0.6	292	1.752
India	3	60	1.8	0.6	737	4.422
Japan	3	197	5.9	0.6	1,826	10.956
Hong Kong	1	21	0.21	0.3	186	0.558
Singapore	3	7	0.21	0.8	113	0.904
Vietnam	2	13	0.26	0.4	31	0.124
China	1	1,869	18.69	0.3	16,674	50.022
Australia	10	37	3.7	1.3	583	7.579
Thailand	1	37	0.37	0.3	249	0.747
Malaysia	2	7	0.14	0.4	140	0.56
South Korea	1	90	0.9	0.3	1033	3.099

Consumer Adoption, Benefits, and Risks

Consumer Adoption, Benefits, and Risks

- **Benefit: credit, especially for consumers with limited means**
  - 45 percent of U.S. adults who were BNPL users said they used these services to make purchases that otherwise would not fit their budget (Backman 2021).
  - convenience
  - transparency of terms, interest avoidance, cash conservation, and less impact to their credit score
  - …

Consumer Adoption, Benefits, and Risks

- **Risk**
  - Impulse buying
  - financial overextension

  - 74 percent of BNPL users were able to make their BNPL payments on time, 14 percent missed a payment once, and 12 percent missed a payment more than once (Piplsay 2021).

Merchant Adoption, Benefits, and Risks

- **Marketing**
  - Merchants experience a decrease in cart abandonment and an increase in repeat business (Todorov 2021)

- **Financial certainty**
  - BNPL products provide merchants the ability to settle sales quickly and may eliminate a merchant's chargeback and fraud risks because BNPL firms assume those risks (Eckler 2020)

Merchant Adoption, Benefits, and Risks

- **Expensive**
  - The cost of a BNPL transaction for merchants ranges from 1.5 to 7 percent of the purchase value (including tax), while the cost of a typical debit or credit card transaction ranges from 1 to 3 percent.

  - Interest-free BNPL payments will attract existing customers away from payment options that cost merchants less to accept, such as debit and prepaid cards (Southall 2021)

Thank you!

Reminder: the first individual assignment is due before next lecture. (6:30 PM, 29 Aug)

Reference: Alcazar, J., & Bradford, T. (2021). The appeal and proliferation of buy now, pay later: Consumer and merchant perspectives. *The Federal Reserve Bank of Kansas City*, *10*.